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SVIC NOTES

WHAT PRICE TESTING?

Many statements about the increasingly high cost of testing have appeared in the shock and vibration literature over the past few years; however, I don't believe the high cost of testing alone is the issue. The real issue is the cost effectiveness of testing.

Testing has become more expensive in recent years because larger and more complex systems have been developed. Sometimes there is a desire, or even a requirement, to test these at the complete assembly level. These tests are often expensive because dedicated test facilities are needed to properly conduct the test. But, once all of the necessary technical and cost factors are evaluated, many believe that these tests are not likely to be cost effective. Therefore, when it is necessary to qualify large systems, a current trend is not to test at the complete assembly level if more cost-effective procedures are available.

The introduction of a number of new types of tests is another reason why testing has become more expensive. These tests are often incorporated in many test programs, and while they may increase the development costs, they are potentially cheaper in the long run if they are run properly. Published experience with one of the new tests, production screening, has shown that it results in more reliable equipment. The same can be said for reliability demonstration tests using the recently developed CERT procedures. These tests have been considered to be cost effective because they reduce maintenance and operating costs, which leads to lower material life cycle costs.

However, the introduction of these new tests has caused some confusion within the shock and vibration technical community. I believe there is confusion over the purpose of some of these new tests. I believe there is confusion over the appropriate test criteria, and I believe there is confusion over the appropriate level of assembly for testing. The last two items apply largely to production screening tests; test tailoring is certainly needed to maximize their effectiveness. This is not to criticize the introduction of these new tests. Experience has shown that they are needed and that they are beneficial. Confusion is inevitable whenever new concepts are introduced; and in this case, it could reduce the effectiveness of an entire test program. Therefore, it is important to recognize the existence of any misunderstandings and clear them up immediately.

R.H.V.

EDITORS RATTLE SPACE

ENGINEERING PRACTICE TODAY

It appears that innovative research and development activity is almost nonexistent in today's engineering and scientific practice. Simulation of the behavior of physical phenomena on the digital computer has advanced to the state where problems involving thousands of degrees of freedom can be solved. Perhaps the development of the digital computer has been the cause of the drift away from innovation and good engineering practice to solving problems by means of numerical overkill.

Scientific and engineering pursuit of the understanding of physical phenomena and the solution of problems began years ago when man needed bridges, power, etc. In the vibration area, his association with music probably evoked the first interest in vibrations. Today's state of the technology progressed through eras involving physical understanding, development of mathematical characterization and solution techniques, and development of experimental equipment and techniques. Finally the electronic computer came along bringing with it the ability to attack massive problems. The only trouble with this progression of developments is that engineers put more emphasis on computers and less on engineering.

In view of the orientation of the papers offered at recent conferences, the era of the 1970's was one of solidification of existing technology. Working virtually the same problems on a more grandiose scale seems to be current practice. It is time to emphasize more innovation and physical understanding in the solution of practical problems. In all probability, physical understanding can only come with more basic experimentation. Characterization exercises in areas like structural and mechanical damping would in all likelihood change the mathematical models or approaches we now use. It is almost certain that the complexity, in numerical size, or many problems facing engineers today could be reduced if techniques were emphasized which yielded essential data without producing meaningless detailed numbers as byproducts. Better physical understanding of the phenomena involved in the problem would allow generalization and total problem understanding in many instances.

It appears to me that steps must be taken in the education process to emphasize innovation and engineering at the expense of the more automatic computer oriented courses. Secondly, too little emphasis is placed on physical understanding through experimental means. It is of course less expensive and more convenient to emphasize mathematically oriented understanding. But it is precisely this type action that leads us to the state of our technology today. I am in no way trying to understate the value of mathematical analysis and electronic computers because innovation is necessary in these areas, but now is the time to start placing things in perspective.

R.L.E.

CURRENT TOPICS IN ROTORDYNAMICS RESEARCH

J.W. Lund*

Abstract. ***This article describes destabilizing effects due to passive forces on flexible rotors. Recent advances in modeling rotor/bearing systems are also summarized.***

With the demand for higher power density in modern machinery, shafts have become relatively more flexible and consequently more sensitive to vibrations. In particular, rotor susceptibility to self-excited whirl (instability) has increased such that a number of destabilizing effects, which hitherto have been considered too weak to be of any practical concern, now have to be examined more carefully.

PASSIVE REACTION FORCES

In investigations the reaction forces (passive forces) are assumed to be linearly dependent on the lateral vibration displacements. Hence, with displacements x and y the corresponding dynamic reaction forces R_x and R_y are expressed by:

$$\begin{Bmatrix} R_x \\ R_y \end{Bmatrix} = \begin{bmatrix} K_{xx} & K_{xy} \\ K_{yx} & K_{yy} \end{bmatrix} \begin{Bmatrix} x \\ y \end{Bmatrix} + \begin{bmatrix} B_{xx} & B_{xy} \\ B_{yx} & B_{yy} \end{bmatrix} \begin{Bmatrix} \dot{x} \\ \dot{y} \end{Bmatrix} + \begin{bmatrix} C_{xx} & C_{xy} \\ C_{yx} & C_{yy} \end{bmatrix} \begin{Bmatrix} \ddot{x} \\ \ddot{y} \end{Bmatrix}$$

The K's are stiffness coefficients, the B's are damping coefficients, and the C's are inertia coefficients (virtual mass effect).

Apart from the obvious destabilization caused by negative damping, dynamic instability is basically governed by the cross-coupling stiffness coefficients K_{xy} and K_{yx}, which induce self-excited whirl when they are of opposite sign. Physically this means that the reaction force, in addition to a radial restoring force, also has a tangential component. It is orthogonal to the direction of displacement and drives the shaft into whirl unless opposed by a sufficient damping force.

A potential source for this type of instability is the process fluid in turbines, compressors, and pumps. The concern in this respect is not with such phenomena as stall or surge – these are flow instabilities that, from the point-of-view of rotor dynamics, are categorized as external excitation (active forces). Rather, it is the passive force resulting from asymmetry in the pressure field, as caused by an eccentricity of the wheel, that is being considered.

A well-known example is steam whirl in axial flow machinery. In this case the change in tip seal clearance, following an eccentricity of the wheel, changes the local efficiency and thus causes a circumferential variation in the tangential blade loading. The result is a net force on the shaft that is orthogonal to the displacement direction. With a stage torque T, a pitch radius r, and a vane height H an expression for the cross-coupling stiffness coefficients has been given by Alford [29] as:

$$K_{xy} = - K_{yx} = - \beta \frac{T}{2rH}$$

where β is the relative change in efficiency per relative change in tip clearance. Alford suggested a value for β of the order of – 1; otherwise it is difficult to obtain any data. Additional discussion can be found [23].

For radial flow machinery indications are that the stiffness coefficients depend on mass flow and pressure in a way that is not reflected in the above expression. To study the problem analytically requires a method for computing the flow and pressure fields around an eccentric impeller, but the various idealizations that must be introduced make it difficult to assess the validity of the results. In an example of an analysis [21], values of the coefficients were given as functions of mass flow and found to be in the range

$$K_{xy} \sim 0.1 \rho U^2 b$$

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(ρ = mass density, U = peripheral velocity of impeller, b = impeller width). The accompanying coefficient K_{yx} is of the same magnitude but of opposite sign (destabilizing) only when the mass flow is less than optimum. The analysis applies to a vaneless diffusor (see also [24]), but similar results have been derived in the case of a vaned diffusor [31] from experimental results [32]. Further results [30] are given in terms of damping coefficients B_{xx} (= B_{yy}). For forward circular whirl, as assumed, the coefficient is equivalent to expressing the passive force by means of cross-coupling stiffnesses ($K_{xy} = -\omega B_{xx}$, where ω is the frequency).

The investigations cited arrive at results of the same order of magnitude, typically 10^4 to $5 \cdot 10^4$ N/m. As the analogous coefficients for journal bearings in the same applications are of the order of 10^8 N/m, the calculated impeller coefficients would appear to be insignificant with rare exceptions.

It has been found, however, that the labyrinth seals, which contribute to the destabilizing forces in a similar manner, must also be considered. Alford [29] made an analysis along the same lines as the above analysis for deriving steam whirl coefficients, but recent investigations [1, 3, 4] concur in the necessity to include circumferential flow velocity in the glands in order to account for any dynamic destabilizing effects. The analysis is elaborate, and no simple method suggests itself for presenting the results in a general form because of the large number of parameters involved. The results depend not only on the type of labyrinth seal, geometry, dimensions, fluid properties, and pressure differential but also on circumferential velocity and entry swirl of the flow.

For short seals -- as are usually found in centrifugal compressors -- typical values for K_{xy} (= $-K_{yx}$) are of the order of $(1\text{-}5) \cdot 10^4$ N/m and depend strongly on the assumed amount of entry swirl. Even though this value is as small as the value for the impeller coefficients, the combined effect in a compressor with many stages can cause a noticeable reduction in the stability margin [3]. Whether this reduction is always sufficient to explain the many occurrences of self-excited whirl related to operating flow conditions needs further investigation; but that labyrinth seals are at least partly responsible has been demonstrated in practice when compressors have been stabilized by providing the seals with vortex brakes [2].

For long labyrinth seals as in steam turbines, the entry swirl effect is dominated by the contribution from shaft rotation; here the coefficients can assume relatively larger values. An example has been [3] for a 600MW steam power plant: K_{xy} for the shaft seals is $5 \cdot 10^5$ N/m; the value for the balance piston seal is 10^7 N/m. (The associated radial stiffness coefficient, K_{xx} (= K_{yy}) is negative with values of $-4 \cdot 10^6$ N/m and $-2.7 \cdot 10^7$ N/m respectively.) The corresponding bearing coefficients are of the order 10^9 N/m.

A different type of seal, namely the annular pressure seal, can exert a strong influence in boiler feed water pumps [31, 33] or high-pressure compressors [6]. The seal acts as a cylindrical journal bearing; destabilizing cross-coupling coefficients are given by:

$$K_{xy} = -K_{yx} = 2\pi\Omega\mu L \left(\frac{R}{C}\right)^3 \left(\frac{L}{D}\right)^2$$

where Ω is the angular speed of rotation, μ is the fluid viscosity, C is the radial clearance, R is the radius, D is the diameter, and L is the axial length. Because the coefficients are proportional to L^3, a considerable reduction in destabilization can be achieved by providing the seal with circumferential grooves.

In addition to these cross-coupling coefficients, which are induced by hydrodynamic action, there is an appreciable radial stiffness caused by hydrostatic action. This action can be expressed approximately by:

$$K_{xx} = K_{yy} \sim \frac{\pi LD \cdot \Delta p}{C} \cdot \frac{1-\delta}{1+\delta} \cdot \delta$$

where Δp is the pressure differential across the seal; δ is the fractional entrance pressure loss and is dependent on the leakage rate. In a more realistic analysis [7, 25, 26] it was necessary to include the effects of turbulence and entry swirl. It was not actually possible to separate the hydrodynamic and the hydrostatic actions, as assumed in the above equations. A detailed discussion is available [25].

For a sufficiently high pressure differential, the radial stiffness of a seal can approach a value com-

parable to that of the bearing stiffness. Hence, apart from raising the critical speed, seals can block the ability of journal bearings to provide sufficient damping to the shaft and thereby contribute indirectly to a destabilization of the rotor [27].

MATHEMATICAL MODELS

Concurrent with the effort to determine these more exotic coefficients, work is continuing on testing the dynamic coefficients of bearings. Recent experimental investigations [8, 11] have measured the coefficients for full-scale journal bearings for large power plants; journal diameters are in excess of 0.5m. Hydraulic shakers with harmonic excitation are used. New experimental methods have been developed in which the force excitation is transient [9, 33] or random [10]. Thus far, however, these tests have mainly been confined with one exception [38] to relatively small bearings under laboratory conditions. One of the difficulties in these methods is the proper elimination of the noise caused by the rotation of the shaft. In addition, there is the usual problem of sensitivity to experimental tolerances that is inherent in parameter identification schemes [39]. The obvious advantages of these methods should provide incentive for continued progress.

The interest in analyzing and measuring the various coefficients can be viewed as part of an overall effort to improve and extend the analytical model for the rotor/bearing system. One such extension has been to include the influence from the foundation [13-15, 37] which has become more important with the trend toward less massive and more flexible structures.

Advances in instrumentation, particularly vibration analyzing equipment, has made feasible the formulation of quite realistic foundation models for calculation purposes; but problems still exist in properly accounting for soil-foundation interactions and in representing the machine casing. The latter problem complicates the question of defining a rotor-foundation interface [13]: from an analysis and calculation point-of-view, it would be natural to have the interface at the bearings and consider the casing part of the foundation, but practical considerations can dictate that the interface be taken between machine and foundation. In either case, however, a model of the casing is needed. Apart from specific instances of measured impedances at the bearing pedestals little information is presently available.

The need for an accurate and representative rotor system model has also grown with the increasing application of machinery vibration monitoring. Analysis and calculations can provide the background for frequency identification and diagnostic interpretation of measured signals. As a special example, the formation of transverse cracks in large generator rotors gives rise to parametric resonances that can be used as a possible detection method. This problem has become quite serious in recent years and has been the subject of several investigations [12, 34-36].

In general, the analyses and calculation methods of rotor dynamics have been widely accepted as part of the design procedure for modern machinery [2, 16, 17, 27, 28]. Thereby a more detailed frame is available for evaluating actual field experience. The result should be further improvements and a broadening of the state of the art.

CONCLUSION

In conclusion it should be noted that the reference list is intended to be representative and is in no way complete. The bulk of the references is taken from just two proceedings; they are complemented by a few articles from other publications. Additional references on the various subjects can be found in more detailed lists [1, 3, 21, 23, 25, 27].

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LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains articles about damping in structural joints and seismic analysis of rotating mechanical systems.

Dr. C.F. Beards of Imperial College of Science and Technology, London, England has written an article about the prediction of the effects of joint damping on the vibrations of a structure.

Drs. V. Srinivasan and A.H. Soni of Oklahoma State University, Stillwater, Oklahoma have written a review of the available literature in the area of seismic analysis of rotating mechanical systems. Models used and results obtained by various authors are presented.

DAMPING IN STRUCTURAL JOINTS

C.F. Beards*

Abstract. ***The inherent damping of fabricated structures can be greatly increased without impairing the integrity of the structure by controlling the clamping forces in joints. Furthermore, the frequencies at which resonance occurs can be controlled. Although some surface damage is inevitable in joints designed to dissipate vibrational energy by relative interfacial slip, special surface preparations can reduce this damage to acceptable levels in most structures. Linearized analyses provide adequate qualitative prediction of the effects of joint damping on the vibrations of a structure.***

In many present-day structures it is no longer practical to avoid the excitation of resonance; thus it is necessary to design high levels of damping into these structures to obtain acceptable dynamic performance. Because about 90% of the inherent damping in most structures arises in structural joints, the dynamic performance of a structure can be greatly influenced by controlling the damping that occurs in some of these joints.

In previous studies of damping in structural joints [1, 2] it was concluded that, of the various damping mechanisms that can occur in a joint, relative macroslip between joint interfaces in the plane of the joint provides the greatest damping. However, other damping and slip mechanisms also provide useful dissipation of vibrational energy.

An optimal clamping force has been found to exist under which a joint dissipates maximum vibrational energy, but a clamping force different from this optimum is necessary to minimize the vibration response of a structure. Fretting corrosion can be controlled by careful preparation of joint interfaces.

DAMPING EFFECTS

Joints. Coulomb damping is commonly applied to vibration isolation problems [3, 4]. The relative slip is deliberately large, so that coulomb friction is utilized solely as a damping mechanism and imparts little, if any, structural support. Most engineering applications require maintenance of structural integrity; thus, the relative slip in joints must be very small if they are to be used for vibrational energy dissipation and as fasteners.

The damping behavior of bolted joints has been examined, and useful experimental findings have been reported [5-9]. Of particular interest is consideration of vibration transmission paths in structures [10].

Structural response. Friction damping of resonant turbine blade vibration has been obtained by introducing lacing wires and by controlling slip at the blade root [11-15]. It has been concluded that through the introduction and control of friction damping by means of the friction clamping force in the blade root, a blade may operate successfully at resonance. This would not otherwise be possible since the normal material and aerodynamic damping are only a small fraction of the friction damping potential.

The damping of vibration of plates by fabricating them from contacting laminates has been shown to be effective [16]. Controlling the slip between a plate and its edge supports produced even greater damping [16, 17]. In one case the loss factor was increased by a factor of 20 by correctly clamping the plate edges [16]. The application of friction damping to the joints in structures containing beams and frameworks has also been considered [18] with encouraging results.

Surface damage. Some surface damage is inevitable in joints designed to dissipate vibrational energy by relative interfacial slip. The two effects -- friction damping and fretting corrosion -- are inseparable. However, much work has been done on the mecha-

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nism of material removal and wear during fretting [19-21] and on the use of surface preparations to reduce the damaging effects of fretting. A particularly beneficial surface preparation is electro-discharge machining, or EDM [22]. EDM joints have high static and dynamic stiffness and possess up to 100% more damping capacity than ground joints; surface damage due to fretting can be reduced by an order of magnitude.

CONCLUSIONS

Current trends in structural design, the high energy sources available, and the low noise and vibration levels required mean that structures must possess more damping than is generally the case at present. Increased reliance on joint damping has thus become inevitable, as has the need to design more damping into the joints of a structure.

Increasing the inherent damping in a structure by controlling joint damping is economically and environmentally desirable; large increases in inherent damping are possible. The damaging effects of fretting corrosion can be controlled to some extent; in any case the surface damage occurring in a joint might be preferable to the high vibration amplitudes and stress levels that would otherwise exist in the structure.

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SEISMIC ANALYSIS OF ROTATING MECHANICAL SYSTEMS - A REVIEW

V. Srinivasan and A.H. Soni*

Abstract. ***The need to design reliable machines for earthquake environments has focused attention on the seismic analysis of rotating mechanical systems. This article reviews the available literature in this area and presents the models used and results obtained by various authors.***

The dynamics of rotating machines has been a topic of interest to designers and research engineers for many years. Most studies have focused on the following:

- rotor stability
- balancing of the rotor
- dynamic response of the rotor

Dynamic response studies include response due to mass unbalance and response due to such environmental effects as foundation excitation.

The performance of rotating machines on such moving vehicles as aircraft was a major concern of early designers and led to investigations on the dynamic response of rotating machines to foundation excitation. Research in this area has recently been revitalized because of concern regarding the performance of rotating machines in earthquake environments. In such emergency installations as hospitals and fire stations and in nuclear power plants certain rotating machines must remain functional during and after an earthquake.

Figure 1 shows the primary circuit of a typical nuclear steam supply system in a pressurized water reactor. The heat generated in the reactor is carried by a primary fluid that condenses in a steam generator that transfers heat to a secondary fluid. The condensed fluid is then pumped up to the reactor by the reactor coolant pump. This pump is vital to the nuclear steam supply system and is the heart of the power plant. Failure of this pump could lead to core meltdown in the reactor with catastrophic consequences. It is therefore essential that this pump remain functional in the event of seismic activity.

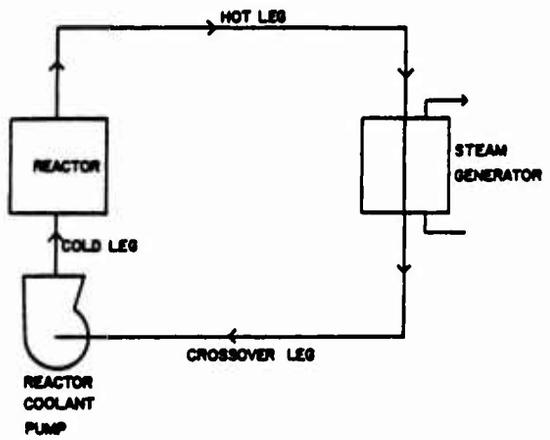

Figure 1. Typical Nuclear Steam Supply System

The seismic analysis of rotating machines basically involves a transient dynamic response computation. The computation is performed after the rotor/bearing system has been suitably modeled and the foundation base has been subjected to a motion that simulates an earthquake. From these computations the designer checks the following, whether

- the lubricant fluid film preserves a minimum thickness at all times so that the rotor and bearing surfaces do not rub against each other
- the dynamic stresses induced in the rotor stay within allowable limits
- the bearing reaction forces can be adequately withstood by the supporting structures

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Dynamic response computations in the seismic analysis can be carried out using any of the following methods:

- time history analysis, in which base excitation as well as response are treated in the time domain
- response spectrum analysis, in which excitation and response are considered in the frequency domain
- spectral density analysis, in which excitation and response are analyzed as random vibrations

All of these methods have been employed in the seismic analysis of rotors.

The difference between the seismic analysis of stationary structures and rotating structures must be pointed out at this point. Seismic analysis of stationary structures is well-developed and has become a routine practice in industry [1, 2]. Seismic analysis of rotating components is relatively new; it differs from the seismic analysis of stationary structures in that additional gyroscopic effects and rotor/bearing interactions must be considered. It is well known that gyroscopic moments are developed whenever the spin axis of a rotating body is rotated. In rotating machines the spin axis rotates for any of the following reasons:

- overall rotation of the structure supporting the rotating machine
- flexibility of the members supporting the rotor
- differential translational motions of the support points on the rotor

The presence of gyroscopic effects is illustrated in the Table; a simple case of a rigid rotor mounted on two bearings is presented for four cases of base excitation. Three of the four cases involve gyroscopic effects.

A vast literature is available on the general dynamic response of rotors. This review is restricted to models used and results obtained by authors who have specifically addressed the problem of seismic analysis of rotating shafts.

RIGID BODY MODELS

Useful results have been obtained by modeling the rotor as a spinning rigid body. Some accuracy is sacrified in ignoring the flexibility of the rotor itself, but such analyses provide certain physical insight into the problem and avoid complex mathematics.

Tessarzik model. The axial dynamic response of a rotating machine supported on a gas thrust bearing and subjected to stationary random environment has been obtained [3]. The rotor/bearing system was modeled by the linear, discrete parameter system shown in Figure 2. Only the axial vibration of the rotor was considered; the effect of rotation of the rotor was thus ignored. The film thickness of the gas thrust bearing was the primary concern in the analysis. The theoretical random vibration response compared well with experimental measurements obtained on an actual turbomachine, thereby validating the model.

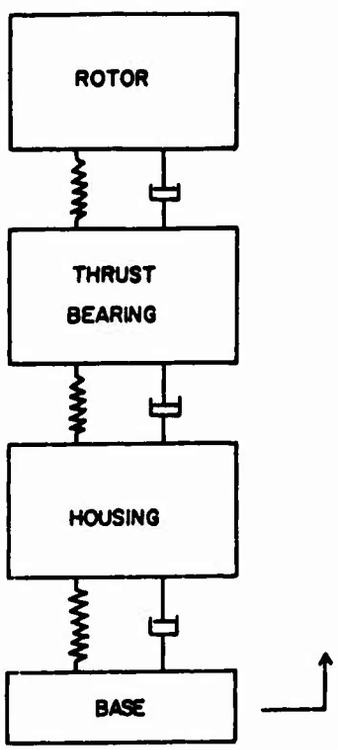
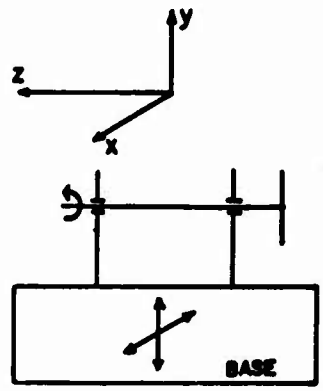
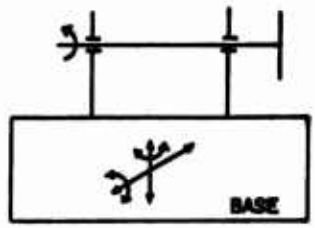
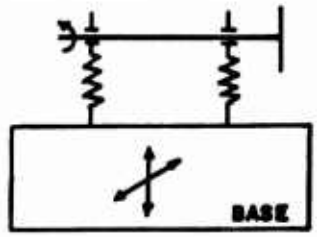
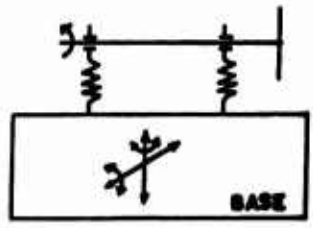


Figure 2. Tessarzik Model [3]

Table. Gyroscopic Effects due to Base Motion

ROTOR-BEARING SYSTEM	DESCRIPTION	REMARKS
	RIGID ROTOR ON RIGID BEARINGS. BASE TRANSLATION ONLY.	NO GYROSCOPIC EFFECT IS FELT.
	RIGID ROTOR ON RIGID BEARINGS. BASE TRANSLATION AND ROTATION.	GYROSCOPIC EFFECTS ARE PRESENT.
	RIGID ROTOR ON FLEXIBLE BEARINGS. BASE TRANSLATION ONLY.	GYROSCOPIC EFFECTS ARE PRESENT EXCEPT FOR A SYMMETRICAL ROTOR ON IDENTICAL BEARINGS.
	RIGID ROTOR ON FLEXIBLE BEARINGS. BASE TRANSLATION AND ROTATION.	GYROSCOPIC EFFECTS ARE PRESENT.

Nakamura-Asmis model. The dynamic response of a uranium centrifuge subjected to seismic excitation has been obtained [4]. The centrifuge was modeled as a rigid body spinning in three-dimensional space (see Figure 3). Rotor/bearing interactions were modeled by two sets of orthogonal springs and dashpots at each of the two bearing locations. Loci of the journal centers were obtained for Taft and El Centro earthquake excitations. The uranium centrifuge that was analyzed was found to be safely designed; safety was experimentally confirmed.

A similar model was proposed independently [5, 6] to study the dynamic response of a heat transport pump in the CANDU reactor. Response was obtained as a function of time using numerical integration of the governing equations. Responses were obtained for a unit step base excitation and the El Centro earthquake excitation. Gyroscopic effects were found to be of considerable importance. Contrary to common belief, it was found that gyroscopic effects did not necessarily strengthen or reduce motion of the assembly in the direction of excitation. It was also found that the gyroscopically-induced forces could be kept within reasonable values by providing close fitting, stiff supports. It was suggested that gyroscopically-induced forces could be minimized by mounting the equipment so that the external forces excited only the translational modes.

A rigid body model similar to that described above has been proposed [7] to obtain the transient dynamic response to seismic excitation.

Schweitzer-Iwatsubo model. A refined model for a rotating system can be obtained if the lubricant fluid film and the bearing support are modeled separately as springs and dashpots. Such a model facilitates inclusion of the influence of bearing masses in the analysis. One such model has been proposed [8] and used [9] for seismic analysis (see Figure 4). Emphasis was on reliability analysis. The

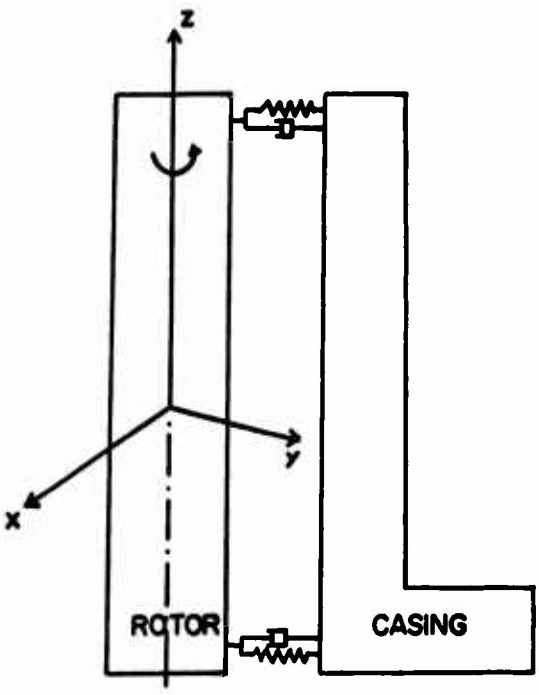


Figure 3. Nakamura-Asmis Model [4-6]

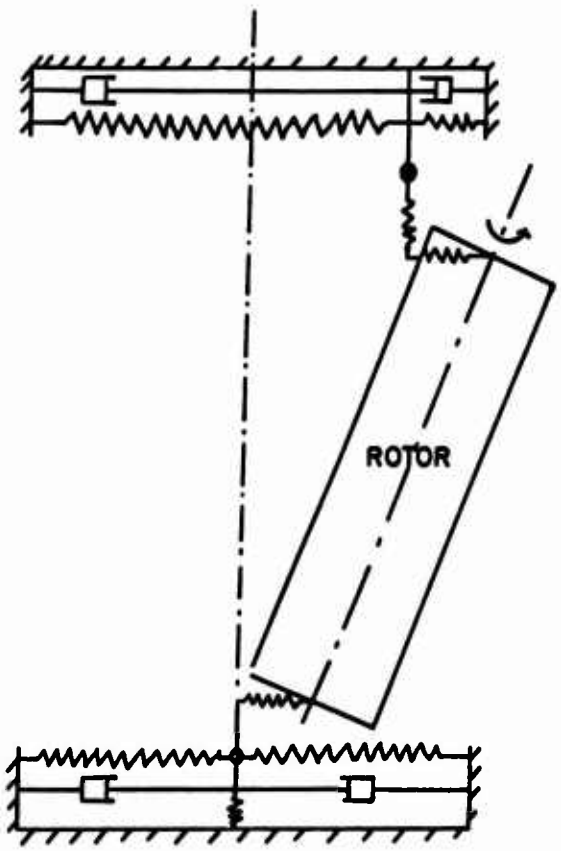


Figure 4. Schweitzer-Iwatsubo Model [8, 9]

earthquake excitation was treated as a nonstationary random process. Such physical parameters as mass, stiffness, and damping coefficients were allowed to vary randomly from their design values. The authors used the principles of random vibration to obtain the displacement response, system failure probability, and the period of first collision with the guard.

Dynamic response of gyroscopes to base excitation has been studied [10, 11], but these studies were restricted to gyroscopes. Rotor/bearing interaction effects were not included in the analyses. Such studies are less likely to be of interest to designers of rotating shafts.

BEAM MODELS

A more realistic model for the rotor is obtained if rotor flexibility is included in the analysis. In a limited number of studies, the rotor has been modeled as a beam for seismic analysis.

Villasor model. The dynamic response of a reactor coolant pump to earthquake excitation has been obtained [12] using the ANSYS finite element computer program. A major feature of this work was the use of beam, spring, and fluid elements to model the rotor and all of its supporting members (see Figure 5). The effect of rotation is not included in the analysis. The seismic analysis was performed using the response spectrum method; seismic velocity was the input excitation parameter. Nodal stresses and displacements were obtained. It was concluded that the reactor coolant pump was adequate to withstand the imposed seismic loading.

Lund model. An important element in the seismic analysis of rotating systems is the proper inclusion of rotor/bearing interaction effects. The nature of interaction is complicated by the fact that the restoring force acting on the rotor in a fluid film is not collinear with the perturbing force. It is therefore necessary to use at least four stiffness and damping coefficients -- two collinear and two cross-coupled in each case -- to describe the dynamic characteristics of a fluid-film journal bearing [13].

The damping coefficients for the fluid-film bearing are symmetric, but the stiffness coefficients are not [14, 15]. This important aspect of the problem has been recognized by Lund [16]. He proposed a beam model for the seismic analysis of a rotor that includes shear deformation, rotary inertia, gyroscopic moments, internal hysteresis damping, and rotor-bearing interaction effects (see Figure 6). The vertical ampli-

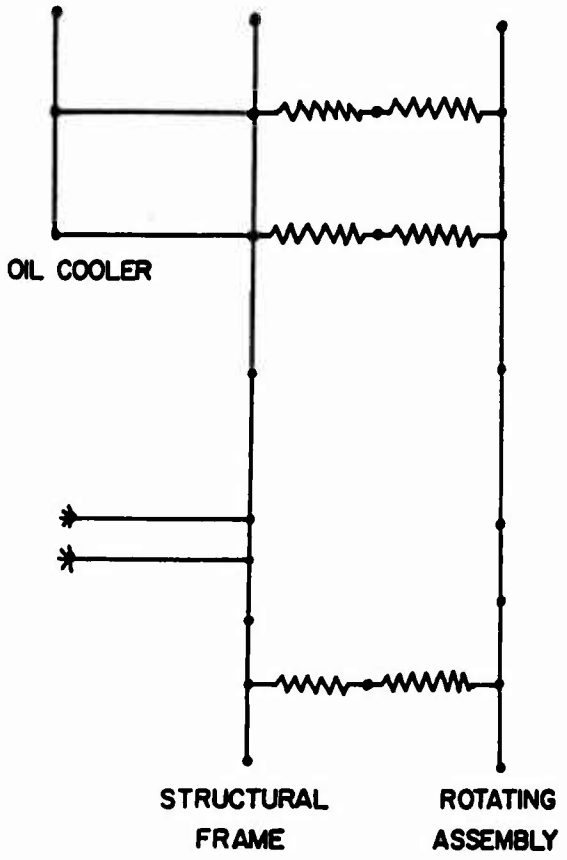


Figure 5. Villasor Model [12]

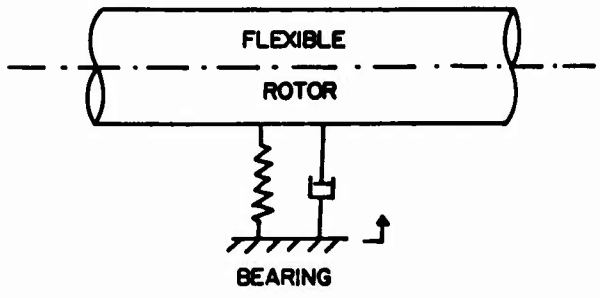


Figure 6. Lund Model [16]

tude response of the rotor due to foundation shock pulse and to random excitation were obtained using a modal method developed earlier [17].

Shimogo model. The seismic response of a rotor supported on two bearings has been obtained [18] by modeling the rotor as a rigid rotor, a flexible rotor with distributed mass, and a flexible rotor with lumped mass (see Figure 7). The seismic excitations acting on the two bearings were assumed to be stationary Gaussian random processes. The rotor-bearing interaction was properly modeled, as done earlier by Lund. The authors concluded that the flexibility of the rotor should be taken into account in the seismic analysis for proper estimation of the bearing reaction forces.

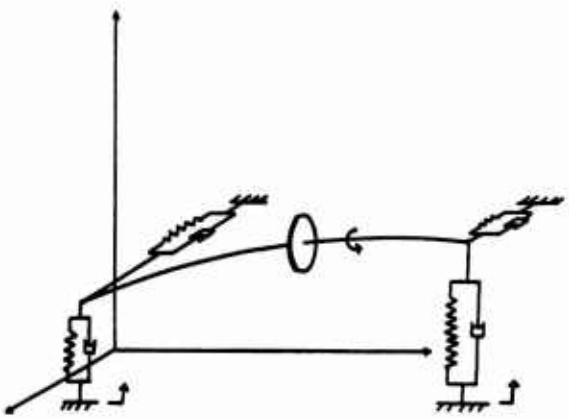


Figure 7. Shimogo Model [18]

CONCLUSIONS

The need to design reliable machines for earthquake environments has focused attention on the transient dynamic response of rotating machines to base motions. This type of analysis differs significantly from traditional structural dynamic analysis because of the presence of gyroscopic effects and rotor-bearing interaction effects.

A rigid body model for the rotor spinning in three-dimensional space seems to be satisfactory for predicting lubrication film thickness and bearing reaction forces when the rotor is supported on only two bearings. In all the models reported in this review, the base is subjected only to translational excitations. A rotating machine mounted on a structure would, however, be subjected to base rotations as well as base translations in an earthquake. A rigid body model for the rotor that includes the additional effects of base rotation has recently been proposed by the authors of this review article.

When the rotor is supported on more than two bearings or the stresses and deflections in the rotor are to be estimated, the beam model should be used. Existing beam models reported in this review do not include the effects of base rotation. Future beam models should account for such rotation.

ACKNOWLEDGEMENT

The authors wish to acknowledge the National Science Foundation Earthquake Hazards Mitigation Program for support via grant CEE 8108119 which made it possible for us to prepare this review article.

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BOOK REVIEWS

NOISE CONTROL SOLUTIONS FOR THE CONSTRUCTION INDUSTRY

R.K. Miller
Fairmont Press, Atlanta, GA
1981, 82 pages, $55.00

This is one of the poorer books in a woefully poor series of so-called texts on noise control solutions. The series includes books containing solutions for the chemical industry, the metal-working industry, and so on. Each book is a very brief compilation of some existing literature dealing with the subject and, if done properly, could be most useful. Other industry-specific books have presented excellent treatments of noise control. Unfortunately, none of the care and detail that went into those studies can be found in the noise control solutions series in general -- and this book in particular.

Each of the 12 chapters consists of a short discussion (often less than ½ page in length) and a group of figures or tables (41 of the 76 pages of text are figures or tables taken from other sources) that provide little useful information about noise control in the construction industry. My brief review of the chapters follows.

1. Community Noise: promotes the unexplained concept of city noise index in which the author claims to provide "a single number descriptor of the overall noise of a city with a reasonable degree of statistical accuracy." The simple concept of Ldn is muddled when he provides both a daytime and a nighttime equation.

2. Construction Noise Levels: provides a table of typical A-weighted sound pressure levels of equipment but no indication of the mode in which the equipment is being operated.

3. Community Exposure to Construction Noise: the text refers to unexplained tables of a reference more than a decade old.

4. Measurement of Construction Equipment Noise: contains a brief but incomplete reference to controlled test methods (not field methods) for jackhammers, portable air compressors, and mobile construction equipment. The author does not discuss the use of data obtained from these tests.

5. Construction Noise Ordinances: a discussion of the New York City Transit Authority contract specifications concerning noise and a typical tunneling permit issued by NYC.

6. Potential for Noise Abatement: the chapter assumes a certain reduction could be provided for generic types of equipment (i.e., 10 dB for backhoes).

7. Portable Air Compressors: directed at the manufacturer, who already is knowledgeable because of EPA regulations.

8. Pile Drivers: the construction alternatives proposed in this chapter would be helpful if they were possible; often they are not.

9. Earthmoving . . . Equipment: also from government documents, perhaps useful for an original equipment manufacturer.

10. Paving Breakers and Jack Hammers: some interesting text in this chapter, but it contains a very superficial treatment of noise control solutions.

11. Other equipment: includes a total 1½ page treatment devoted to concrete vibrators, chainsaws, circular saws, concrete mixers (the author recommends using friction drives instead of gear drives), small elevators, and plastering machines.

12. Economic Impact: an estimated cost of reducing equipment.

Also included are 22 references and 54 citations to applicable documents.

All of the topics are treated so flimsily that, at best, the reader would remember seeing it better explained elsewhere; at worst, the reader would wonder why it was included. There is no index and little original text. Lacking are what I consider important issues: the statistical nature of construction noise and the prediction, measurement, and description of site noise; community impact (including back-up alarms); and the noise emission (and the conditions under which it was measured) of specific equipment such as concrete pumps, mixers, and riveting and welding operations.

To sum up, there are many ways to obtain more information on construction noise than by purchasing and reading this book. Probably all of them will be less expensive and more useful.

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NON-LINEAR OSCILLATIONS

P. Hagedron
W. Stadler, Translator and Editor
Oxford University Press, New York
1981, 289 pages, $85.00

This book contains special topics in the areas of analytic mechanics and optimal control. The theories presented are illustrated by mechanical and electrical problems. The first four chapters deal with the mechanics of nonlinear oscillations; the fifth chapter pertains to optimal control theory. Each chapter ends with a brief review of pertinent literature and a challenging set of problems. Detailed solutions of the problems at the end of each chapter are given.

The first chapter treats the mathematical pendulum as an illustration of linear and nonlinear ordinary differential equations of a single degree-of-freedom system. The dynamic behavior of the damped and undamped motions of the pendulum is examined using perturbation methods, the method of harmonic balance, the Ritz method, the method of equivalent linearization, and the method of slowly varying phase and amplitude. The stability of periodic solutions is treated in terms of phase and cylindrical phase diagrams. Analytical aspects of the existence of periodic solutions of forced motions are discussed. This chapter also includes the analyses of such typical nonlinear characteristics as jump phenomena, subharmonic oscillations, and combination frequencies.

The Lagrange-Dirichlet theorem of mechanics provided impetus for the development of the Liapunov stability theory, which is the main subject of the second chapter. The author demonstrates the application of the direct method of Liapunov with a number of examples. Such related topics as stability by the first approximation for autonomous and non-autonomous systems are addressed.

The theory of self-excited oscillations is treated in the third chapter. Self-excited oscillations in mechanical and electrical systems are analyzed using methods presented in the first chapter. Analytical criteria for the existence of limit cycles are based on the theories of Poincare, Bendixon, and Levinson. The analysis of self-excited oscillations in two-degrees-of-freedom systems is given. Forced self-excited oscillations are addressed, but the influence of parametric excitation on systems with sources of self-excited oscillations is not included.

The analytical mechanics of Hamiltonian systems is presented in the fourth chapter. Hamiltonian differential equations in mechanics are simplified by suitable transformation of variables known as canonical transformation or contact transformation. The Hamilton-Jacobi differential equation and its solution are analyzed. It is shown that the integration of an arbitrary canonical system yields a canonical transformation. The canonical perturbation theory is used to obtain approximate solutions for nonlinear systems, including those with autoparametric coupling that exhibit internal resonance.

The last chapter introduces the theory of optimal control. Conditions for optimality of a solution of the control problem, called the Pontryagin maximum principle, are discussed in terms of Hamiltonian mechanics. The application of the canonical perturbation theory in optimal control problems is demonstrated.

This book will be useful to researchers and graduate students with a strong background in analytical mechanics.

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TIMES SERIES ANALYSIS -- FORECASTING AND CONTROL

G.E.P. Box and G.M. Jenkins
Holden-Day Inc., San Francisco, CA
Revised Edition, 1976, $38.50

Time series analysis (TSA) was at one time in the realm of statisticians. In recent years engineers have begun to use it. As stated by the authors, "This book is concerned with the building of stochastic (statistical) models for discrete time series in the time domain and the use of such models in important areas of application . . . When two or more related time series are under study, the models can be extended to represent dynamic relationships between the series and hence to estimate transfer functions . . . " Box and Jenkins furnish an excellent introduction to time series analysis. The original edition, which was published about ten years ago, is still used by investigators and workers in the field.

The most important feature of this book is the process of model building -- the relation between a class of statistical models and the data at hand. Identification techniques, including autocorrelation and the partial correlation function, are used to determine the kind of model to be employed. The model is fitted to a time series to provide likelihood functions and estimates of parameters. Diagnostic checks are used to detect shortcomings of the model. Modifications, an iterative cycle of identification, fitting, and diagnostic checks are then carried out.

The book consists of 13 chapters. Chapters 1 and 2 are an introduction and summary of the topics in the book and contain a discussion of autocorrelation and the power spectrum approach.

Chapter 3 is, in the reviewer's opinion, one of the most important in the book. It discusses linear structural models and considers a time series generated by a linear combination of random shocks. Linear processes can be represented as a small number of autoregressive moving averages (ARMA). In the reviewer's opinion, ARMA is an important aspect of TSA that until now has been used sparingly by engineers. It has been used recently in earthquake engineering and could be used in gust prediction on aircraft.

Chapters 4 and 5 describe linear nonstationary models and introduce forecasting. Chapter 6 discusses model identification and the various techniques employed, including auto- and partial autocorrelation, initial estimates of the parameters for ARMA, and mixed ARMA.

Chapters 7, 8, and 9 consider the process of model identification, model estimates, diagnostic checking of models, and the entire model building process.

Chapters 10 and 11 introduce transfer function model building by relating a system output to one or more system inputs. The determination of applicable methods for transfer-noise model identification, estimation, and diagnostic checking are described. The reviewer believes that investigation into partial coherence aspects of random vibration and noise would be beneficial. The last two chapters consider the combination of stochastic models and transfer functions and their relationship to the design of simple feedforward and feedback control systems.

This is a good book. It is slanted toward statistics, but engineers can acquire a great deal of information about TSA and the use of ARMA in analysis. The book is self suffucient as to mathematics but is not for the casual reader. The reviewer recommends this bock to engineers who are seriously considering the study of time series analysis.

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SPECTRUM

Comment on "The Literature of Vibration Engineering"
(N.F. Rieger, Shock Vib. Dig., 14 (1), pp 5-13, Jan 1982)

Rieger presents a comprehensive treatment of the current literature, but a number of additional items are of special interest. Thompson (Rieger's reference 18) has a 2nd edition [1] that is up to date. Newland [2] has an excellent introductory text on random vibrations. Crandall's two summer course books [3, 4] are important reference sources for random vibration analysis. Crede [5], Cole [6], and Van Santen [7] have published books with an application flavor and useful examples; alas, all are out of print. Crede's book on vibration isolation [8] is specialized but useful. Ewing, Jardetsky, and Press [9] and Kolsky [10] are useful references for traveling waves. Miklowitz [11] covers mathematics with rigor. Goldsmith [12] is an essential starting point for impact problems.

On the analytical side, Chen [13] is intermediate in level between introductory texts [1] and such advanced treatises as Tong (Rieger's reference 46). McLachlan [14] is compact analytical work with a remarkable coverage of longitudinal, torsional, and flexural vibrations of bars and tubes of various shapes. Haag [15, 16] has two useful books on nonlinear vibrations; emphasis is on the general theory of synchronization.

It should be mentioned that Rieger's citations in acoustics are reference works suitable for engineers with a primary interest in vibrations. There are many texts and a large specialist literature in acoustics including, for example, several on structure-borne noise and fluid-solid interaction.

Other important literature sources that are difficult to classify are monographs and symposia volumes, many of which are tutorial. It is from these and from review articles and handbooks that we learn about about such important topics as damping [17, 18]. Reference [18] is typical of the 20 or 30 bound volumes published each year by ASME. A couple of these are usually of interest to vibration engineers; several others are of interest to specialists in, for example, fluid-solid interaction, offshore structures, or vehicle-guideway dynamics. It is worthwhile to scan ASME's yearly publication list to discover them.

In short, Rieger's article is useful; it is not, nor could it be, exhaustive. The book reviews in the **Shock and Vibration Digest** are an excellent way to keep up with current literature; a complete list of these reviews is given in the Annual Index Issue in December.

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SHORT COURSES

JULY

COMPUTER-AIDED DESIGN OF DYNAMIC SYSTEMS

Dates: July 12-16, 1982
Place: East Lansing, Michigan
Objective: This course presents a structured approach to model building, formulation of state equations, and computer-aided analysis of the models. Applications are drawn from mechanical, electrical, hydraulic, thermal, and mixed-energy systems. Participants get hands-on experience with interactive graphics in engineering design.

Contact: Dr. Ronald C. Rosenberg, Program Director of the A.H. Case Center for Computer-Aided Design, College of Engineering, Michigan State University, East Lansing, MI 48824 - (517) 355-6453.

COMPUTER-AIDED METHODS FOR MODAL ANALYSIS

Dates: July 19-23, 1982
Place: East Lansing, Michigan
Objective: This course introduces both finite elements and modal testing, emphasizing this common theory and pointing out the particular advantages of each method. Hardware includes the GenRad 2507, the Hewlett Packard 5423, and the PRIME 750. Software includes ANSYS, MODAL, PLUS, and SUPERTAB.

Contact: Dr. James Bernard, Director for the Case Center for Computer-Aided Design, College of Engineering, Michigan State University, East Lansing, MI 48824 - (517) 355-6453.

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: July 19-23, 1982
Place: England
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos St., Santa Barbara, CA 93105 - (815) 682-7171.

AUGUST

MACHINERY VIBRATION ANALYSIS

Dates: August 17-20, 1982
Place: New Orleans, Louisiana
Dates: November 9-12, 1982
Place: Oak Brook, Illinois
Objective: In this four-day course on practical machinery vibration analysis, savings in production losses and equipment costs through vibration analysis and correction will be stressed. Techniques will be reviewed along with examples and case histories to illustrate their use. Demonstrations of measurement and analysis equipment will be conducted during the course. The course will include lectures on test equipment selection and use, vibration measurement and analysis including the latest information on spectral analysis, balancing, alignment, isolation, and damping. Plant predictive maintenance programs, monitoring equipment and programs, and equipment evaluation are topics included. Specific components and equipment covered in the lectures include gears, bearings (fluid film and antifriction), shafts, couplings, motors, turbines, engines, pumps, compressors, fluid drives, gearboxes, and slow-speed paper rolls.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

SEPTEMBER

SIMULATION AND ANALYSIS OF COMPLEX MECHANICAL SYSTEMS

Dates: September 6-10, 1982
Place: Northampton, UK
Objective: The goal is to assist participants in becoming proficient in the formulation of equations of motion of complex mechanical systems. With this background, the participants will be able to produce efficient algorithms for the simulation of motions and for the determination of constraint and control forces arising in connection with such systems.

Contact: The Open University, Walton Hall, Milton Keynes, MK7 6AA, Telephone: Milton Keynes 653945, Telex: 825061.

ELEVENTH ADVANCED NOISE AND VIBRATION COURSE

Dates: September 13-17, 1982
Place: Southampton, UK
Objective: The course is aimed at researchers and development engineers in industry and research establishments, and people in other spheres who are associated with noise and vibration problems. The course, which is designed to refresh and cover the latest theories and techniques, initially deals with fundamentals and common ground and then offers a choice of specialist topics. There are over thirty lectures, including the basic subjects of acoustics, random processes, vibration theory, subjective response and aerodynamic noise, which form the central core of the course. In addition, several specialist applied topics are offered, including aircraft noise, road traffic noise, industrial machinery noise, diesel engine noise, process plant noise and environmental noise and planning.

Contact: Mrs. G. Hyde, ISVR Conference Secretary, The University, Southampton S09 5NH, UK - Telephone - (0) (703) 559122 X 2310/752; Telex - 47661 SOTON UN G.

COMPUTER VIBRATION ANALYSIS

Dates: September 21-24, 1982
Place: Naperville, Illinois
Objective: The course deals with the role of the digital computer in solving vibration problems that arise in design, development, and fault diagnosis; fracture analysis is covered in depth. Applications of the computer to vibration problems associated with modeling, computation, and data handling are reviewed. Selection and use of hardware and software for computer analysis are discussed. The course begins with a review of vibration theory and a discussion of the types of vibration analysis available. Methods for obtaining and processing the physical data necessary to construct hardware models are described. Readily available and practical short computer programs are summarized, as are such large dynamic programs as NASTRAN, SAP, and ANSYS. Applications of these programs – including pre-processors and post-processors – are elaborated. Methods for predicting vibration failures that utilize fracture mechanics and finite element crack models are applied to such practical problems as generator motors. Available time-sharing services and the computer equipment required for such time sharing are discussed. Microcomputer hardware and software are reviewed and their capabilities summarized.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

TORSIONAL VIBRATIONS

Dates: September 28-30, 1982
Place: Oak Brook, Illinois
Objective: The course emphasizes methods for diagnosing and solving torsional vibration problems in existing equipment. Methods for controlling and eliminating torsional vibrations during the machinery design process are also described. Examples and case histories are used to illustrate mathematical and experimental techniques. The introductory lectures include a short review of basic torsional vibration concepts and a classification of excitations from various types of machines. A discussion of natural frequencies, mode shapes, critical speeds, and torsional vibration response includes the relationship of these factors to mechanical design and analysis. Such criteria for evaluating torsional vibration as strength and motion are discussed, as is the application of these criteria to solving machine problems; allowable stresses and motions are given. Requirements, sources, and techniques for measuring and calculating parameters for the acquisition of design

data are topics for several lectures. Data from blueprints and physical measurements are used to model systems and components for such parameters as stiffness, damping, and mass. Models of physical systems, explicit formulas, and the Holzer method are used to calculate such parameters as natural frequencies and mode shapes. Several lectures are devoted to steady and transient forced vibration responses and include the measurement and analysis of motions and stresses. Techniques involved in premeasurement, calibration of sensors, and actual measurement of forced vibration are discussed and demonstrated. Case histories are used to illustrate what, where, and how to measure and analyze specific torsional vibration problems on such components as pumps, compressors, gearboxes, engines, motors, and couplings. Torsional/lateral interactions in rotors, gearboxes, and pumps are described. Such techniques of vibration control as tuning, reduction of excitation, damping, and isolation are elaborated. Selection of the proper coupling for vibration control and for capability to prevent misalignment is emphasized.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

OCTOBER

UNDERWATER ACOUSTICS

Dates: October 4-8, 1982

Place: State College, Pennsylvania

Objective: The course is designed to provide participants with a broad, comprehensive introduction to underwater acoustics and related topics which will be of immediate practical value; and to provide a foundation for more advanced study of current literature or other specialized courses. Topics presented inlcude underwater sound propagation, sonar concepts, ambient noise and other environment considerations, sonar electronics and signal processing, transducer technology, non-linear acoustics and parametric arrays, target physics, and radiated and self-noise due to turbulent flows and cavitation. Each of the instructors for this course are actively involved in both the theoretical and practical aspects of the material they will present, and will be happy to confer on individual questions or problems.

Contact: Alan D. Stuart, Course Chairman, The Applied Research Laboratory, The Pennsylvania State University, P.O. Box 30, State College, PA 16801 - (814) 865-1397.

INFORMATION RESOURCES

DATA & ANALYSIS CENTER FOR SOFTWARE (DACS)

BACKGROUND

The DACS is a Department of Defense (DoD) information analysis center sponsored by the Air Force Systems Command, Rome Air Development Center (RADC), and operated by IIT Research Institute (IITRI).

The DACS was established in response to a well recognized need for a facility to serve as a centralized source for current, readily usable data and information concerning software technology. A contract was issued to IITRI to organize, staff, and operate the DACS. The facility is located at the Rome Air Development Center, Griffiss Air Force Base, New York. Established in September 1978, the DACS was operated as a pilot facility until September 1981. User response during the pilot period indicated that expansion to full scale operations was a feasible undertaking. As of April 1981, the DACS was designated a Defense Logistics Agency (DLA) Information Analysis Center (IAC).

FUNCTIONS

The DACS functions are:

- To develop and maintain a computer database of empirical data collected on the development and maintenance of computer software.
- To produce and distribute subsets of the database for use by software researchers.
- To maintain a software technology information base of technical documents, project status information, and evaluation data pertinent to the computer software field.
- To analyze the data and information and produce technical reports.
- To maintain a current awareness program which includes dissemination of technical information, assessments of technological developments, and publication of a quarterly newsletter.
- To provide technical assistance in the form of technical information and special studies of topics related to software engineering and software technology.

PRODUCTS

Typical products provided by the DACS include subsets of the Software Life Cycle Empirical Database (SLED), data compendiums, analysis reports, bibliographies, newsletters, a software engineering glossary, and technical monographs. DACS services include accumulating, maintaining and tailoring data subsets for software technology research; bibliographic searches that provide rapid access to documents, reports, anc papers concerning software engineering and software technology; and special technical studies which include technology assessments, critical reviews, and state-of-the-art surveys. Capsule summaries of currently available products follow.

THE DACS SOFTWARE LIFE CYCLE EMPIRICAL DATABASE AND RELATED PRODUCTS

The DACS Software Life Cycle Empirical Database (SLED) presently consists of five sets of data distinguishable by data source, data collection and acquisition methodology, life cycle phase represented and data parameters present. These datasets are described separately below.

Baseline Software Dataset. This dataset contains data describing software problem reports acquired by RADC from six large software development efforts, and consists of 26,594 Software Problem Report

records, 2719 Run Analysis Report records, and 2591 Module Description records.

Software Reliability Dataset. This dataset contains failure data on 16 software systems collected during the phases of software test and operation.

DACS Productivity Dataset. This dataset contains summary information from over 400 software projects, incorporating productivity data, error data, project duration, total effort, language data, and information on the usage of various software implementation technologies.

NASA/SEL Dataset. The Software Engineering Laboratory (SEL), at NASA Goddard Space Flight Center, was organized in August 1976 to monitor existing software methodologies and to develop and measure the effectiveness of alternative methodologies. To accomplish these objectives, the SEL has been collecting data during the development of NASA/SEL software projects. The dataset contains over 45,000 records; the majority is from component status reports, and run analysis reports. The remainder is project comment information, change reports, resource summary reports, and component summary reports.

V&V Dataset. This dataset contains data collected during the independent verification and validation of five software projects. The dataset consists of general project development background information and nearly 1500 anomaly reports on these projects.

Standardized Productivity Dataset. Common elements of the DACS, NASA, and V&V datasets have been combined into one dataset using a standardized record format. This combined dataset contains those parameters which have been identified as most common across the three datasets.

At this time, the DACS is distributing copies of the Software Reliability Dataset, the DACS Productivity Dataset, the V&V Dataset, and the DACS Standardized Productivity Dataset in standard formats. Subsets of the Baseline Software Dataset and the NASA/SEL Dataset are available at costs dependent upon processing time.

RELATED PRODUCTS OF THE SLED

NASA/SEL Data Compendium. This DACS compendium provides specific information on 29 software development projects monitored by NASA/SEL during the 1976 - 1979 time frame. This information includes descriptions of data collection techniques, statistical and graphical data summaries, analysis of data quality and completeness and a discussion of the potential application of the data in statistical and modeling studies in 126 pages of text, charts, graphs, and forms.

A Comparison of DACS and NASA/SEL Software Development Data. This DACS Technical Monograph examines the effect on seven statistical relationships when the productivity data from the NASA/SEL Dataset is combined with the DACS Productivity Dataset. This monograph contains 7 pages of text plus 21 pages of graphs.

BIBLIOGRAPHIC SERVICES AND RELATED PRODUCTS

Custom searches provide the user with references to the latest available information relating to his specific information need. Based upon a statement of specific user needs, DACS conducts a computerized search of its databases to identify applicable reports, project summaries, and journal articles. The search strategy may include any combination of the following data items:

> Subject terms (keywords), personal authors(s), corporate author, sponsoring agency, report date, report number, contract number, journal in which published, title or title fragment.

Bibliographies produced contain all of the above data elements, in addition to an abstract describing the document's contents for all citations retrieved.

The Users' Guide to Bibliographic Services - Custom Searches (BIBGUIDE) is a guide for requesting a DACS bibliographic search and also contains the DACS Software Engineering Thesaurus of keywords used for indexing and retrieving software engineering documents.

DACS Annotated Bibliography. The DACS Annotated Bibliography provides references to over 2000 documents concerning computer software and computer technology. In addition to providing complete citations and abstracts for each document, the

bibliography provides an author index, a subject index, the DACS Software Engineering Thesaurus of indexing terms and a keyword-in-content (KWIC) index. The bibliography contains over 900 pages in two volumes.

The DACS Glossary. The DACS Glossary contains over 1100 terms and their definitions compiled from the software engineering literature.

A Directory of Software Engineering Research Projects. This document contains information on research in software engineering which is either in process or has been recently completed. The information provided includes subject of research, principal investigator(s), sponsor of research, contract or grant number, if applicable, expected data of completion, and a descriptive summary of the research aims, methods, and expected results. The document contains descriptions for 174 projects, as well as indices to the subject of the research, research personnel, and a title index.

AIAA Tool Survey. The AIAA Technical Committee on Computer Systems conducted a survey on software development tools. The complete survey forms are being reproduced, bound into two volumes, and distributed by the DACS. The survey contains information on 293 tools, arranged in alphabetical order by tool title. The tool information includes the tool title, acronym (if any is used), the tool category, the distributor/developer of the tool, the computer on which the tool can be used, the tool source language, documentation availability, and whether or not the tool is in the public domain.

DATA COLLECTION FORMS

As part of an effort to promote the standardization of software engineering data collection and in response to requests from many of the individuals who were approached as part of their data acquisition activities, the DACS has designed and distributed data collection forms. The objective in designing these forms was to make data collection as easy and fast as is consistent with the concerns of accuracy. These forms are designed to be completed at various stages of the software life cycle. The forms can be used to collect data which will support cross comparisons with data already in the DACS database and can also be used to collect data to support identified research aims of the DACS for which data has not yet been available. The DACS is also willing to tailor these forms to the needs of individual organizations collecting or planning to collect data. Data collection forms currently available from the DACS are:

DACS Productivity Data Collection Forms. Forms designed to collect software life cycle productivity-related data. The set contains 2 forms and 8 pages of definitions and guidelines for use of the forms.

DACS Conversion Data Collection Forms. Forms to be used to describe software conversion projects, including system characteristics, personnel and resource expenditures, and problems encountered. The set contains 3 forms and 13 pages of definitions and guidelines for using the forms.

NASA/SEL Life Cycle Data Collection Forms. In addition to the above, forms developed by NASA/SEL are also available from the DACS. These forms can be used to collect detailed productivity, fault, change, and complexity data on all phases of the life cycle. This set contains 12 pages of forms and 26 pages of definitions and guidelines for use of the forms.

STATE-OF-THE-ART REPORTS

Quantitative Software Models. This report contains summary descriptions of 40 models which can be used to predict or assess software productivity, reliability, and complexity. Information provided includes the major assumptions of each model, the data parameters needed to exercise them, and the applications for which the models are suitable. Matrices are included for each model category which correlate the data parameter requirements and outputs to each model in the category. This report contains 147 pages.

A Review of Software Maintenance Technology. This report presents a comprehensive statement about software maintenance techniques and tools in use today, focusing on software maintenance technology as it is described and defined in the open literature and in technical reports. An overview of the software maintenance environment is presented, maintenance activities in the Operations and Maintenance (O&M) phase are discussed, and a set of maintenance technology functions are defined and correlated with the

maintenance activities. Each maintenance tool and technique is described using a format that includes the characteristics, reference sources, status of usage, description, research findings from use, and reports of actual usage in maintenance. The report contains 221 pages including an extensive bibliography and a glossary of terms.

PARTICIPATION PLANS

Because timeliness of response often determines the value of information services, the DACS offers participation plans. By enrolling in a participation plan, a member may access DACS resources as needed without the delay of issuing individual purchase requests. A telephone call can begin the processing of a service request and turnaround may be as short as one day, depending upon the nature of the request. Two plans are currently being offered, enabling users to select the service level that best satisfies their particular needs.

For more information on the DACS participation plans or on special studies contact DACS by letter or telephone. Address inquiries to: DACS, RADC/ISISI, Griffiss AFB, NY 13441, or telephone Shirley Gloss-Soler, Program Manager at (315) 330-3395 or (315) 336-0937.

DACS NEWSLETTER

The DACS Newsletter is a quarterly publication that is intended to provide its readers with a general awareness of significant developments, trends, and technical activities in the software field. The DACS Newsletter is disseminated free-of-charge and may be obtained by calling or writing the DACS. If writing, please be sure to give your complete address.

SERVICE CHARGES

The DACS was operated as a pilot center from September 1978 through August 1981. During the pilot period DACS did not charge for any of its products or services. In April 1981 the DACS was designated a Defense Logistics Agency (DLA) information analysis center (IAC). As a DoD/DLA IAC the DACS was required to institute a system of user charges with the object of recovering a significant portion of the cost of operating the DACS. Under the cost recovery program, those products of substantial nature which were distributed free by the DACS during its pilot phase are now distributed at a price which recovers their reproduction, handling, and mailing costs. Products developed since the DACS was designated a DLA IAC are distributed at a price designed to recover a portion of their development cost as well as the cost of reproduction, handling and mailing.

To obtain more complete descriptions of DACS products and services as well as current prices write or telephone the DACS and request a free copy of the DACS Users' Guide. Address your request to A. Martin, Data & Analysis Center for Software, RADC/ISISI, Griffiss AFB, NY 13441. Ms. Martin can be reached by telephone at (315) 336-0937 or Autovon 587-3395.

ABSTRACT CATEGORIES

MECHANICAL SYSTEMS

- Rotating Machines
- Reciprocating Machines
- Power Transmission Systems
- Metal Working and Forming
- Isolation and Absorption
- Electromechanical Systems
- Optical Systems
- Materials Handling Equipment

STRUCTURAL SYSTEMS

- Bridges
- Buildings
- Towers
- Foundations
- Underground Structures
- Harbors and Dams
- Roads and Tracks
- Construction Equipment
- Pressure Vessels
- Power Plants
- Off-shore Structures

VEHICLE SYSTEMS

- Ground Vehicles
- Ships
- Aircraft
- Missiles and Spacecraft

BIOLOGICAL SYSTEMS

- Human
- Animal

MECHANICAL COMPONENTS

- Absorbers and Isolators
- Springs
- Tires and Wheels
- Blades
- Bearings
- Belts
- Gears
- Clutches
- Couplings
- Fasteners
- Linkages
- Valves
- Seals
- Cams

STRUCTURAL COMPONENTS

- Strings and Ropes
- Cables
- Bars and Rods
- Beams
- Cylinders
- Columns
- Frames and Arches
- Membranes, Films, and Webs
- Panels
- Plates
- Shells
- Rings
- Pipes and Tubes
- Ducts
- Building Components

ELECTRIC COMPONENTS

- Controls (Switches, Circuit Breakers)
- Motors
- Generators
- Transformers
- Relays
- Electronic Components

DYNAMIC ENVIRONMENT

- Acoustic Excitation
- Shock Excitation
- Vibration Excitation
- Thermal Excitation

MECHANICAL PROPERTIES

- Damping
- Fatigue
- Elasticity and Plasticity

EXPERIMENTATION

- Measurement and Analysis
- Dynamic Tests
- Scaling and Modeling
- Diagnostics
- Balancing
- Monitoring

ANALYSIS AND DESIGN

- Analogs and Analog Computation
- Analytical Methods
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- Parameter Identification
- Mobility/Impedance Methods
- Optimization Techniques
- Design Techniques
- Computer Programs

GENERAL TOPICS

- Conference Proceedings
- Tutorials and Reviews
- Criteria, Standards, and Specifications
- Bibliographies
- Useful Applications

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of articles abstracted in the DIGEST are not available from the SVIC or the Vibration Institute (except those generated by either organization). Inquiries should be directed to library resources. Government reports can be obtained from the National Technical Information Service, Springfield, VA 22151, by citing the AD-, PB-, or N- number. Doctoral dissertations are available from University Microfilms (UM), 313 N. Fir St., Ann Arbor, MI; U.S. Patents from the Commissioner of Patents, Washington, DC 20231. Addresses following the authors' names in the citation refer only to the first author. The list of periodicals scanned by this journal is printed in issues 1, 6, and 12.

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MECHANICAL SYSTEMS

ROTATING MACHINES

82-1132
Conditions for Backward Synchronous Whirl of a Flexible Rotor in Hydrodynamic Bearings

J.S. Rao
Indian Inst. of Tech., New Delhi, India, Mech. Mach. Theory, 17 (2), pp 143-152 (1982) 4 figs, 16 refs

Key Words: Rotors, Hydrodynamic bearings, Unbalanced mass response, Critical speeds

This paper deals with the dynamic unbalance response of a single mass Jeffcott rotor in hydrodynamic bearings. The cross-coupled spring coefficients are considered in the analysis and damping has been neglected. It has been shown that there could be either two distinct critical speeds of the rotor with a backward synchronous whirl between them, or that there is no possible conventional critical speed of the rotor. Two case studies are presented.

82-1133
A Variational Approach to the Analysis of Rotor Dynamics Problems

R.A. Mayo
Dept. of Mech. Engrg., Manhattan College, New York, NY 10471, J. Lubric. Tech., Trans. ASME, 104 (1), pp 76-83 (Jan 1982) 3 figs, 11 refs

Key Words: Rotors, Shafts, Variational methods

The differential equations for a rotating shaft system are derived variationally by the use of the Lagrange equations, where the kinetic and potential energy terms are obtained by integration of differential volume expressions which are in turn derived from system displacements and strains. Included, as a result, are the effects of initial and dynamic shaft curvature, gyroscopic moments, Coriolis forces, unbalances, rotatory inertia, static weight, and varying shaft cross-sections. Shown to be insignificant are the interacting effects of transverse shear, extensional displacements (and therefore axial constraint), torsion, product of inertia (for most shaft elements). Bearing forces are included as generalized forces on the shaft system. A sample solution of the equations uses the short bearing approximation to model bearing forces and derives expressions for shaft critical speed, equivalent bearing stiffness, and damping constants as functions of bearing eccentricity.

82-1134
Parametric Instability of a Rotating Shaft Due to Pulsating Torque

A. Unger and M.A. Brull
School of Engrg., Tel Aviv Univ., Tel Aviv, Israel, J. Appl. Mechanics, Trans. ASME, 48 (4), pp 948-958 (Dec 1981) 7 figs, 6 tables, 9 refs

Key Words: Shafts, Flexural vibration, Torsional excitation, Parametric response

The torque transmitted by a shaft is usually a pulsating one which may, under certain conditions, cause transverse parametric oscillations of the shaft leading to its failure. In this paper an analytical numerical investigation is presented to determine the stability regions of the shaft due to a pulsating torque applied at its ends. The present work deals with three types of parametric instabilities -- unstable regions bounded by oscillatory motions characterized by period T and by period 2T and combination resonance. The results indicate that the most common and dangerous parametric instabilities arise as a result of combination resonance.

82-1135
Vibrations of Rotors Supported by Journals Having a Non Symmetrical Stiffness Matrix (Vibrations de Rotors sur Paliers a Matrice de Raideur non Symétrique)

G. Lallement, H. Lecoanet, and W. Steffen
Laboratoire de Mécanique Appliquée associé au CNRS, Faculté des Sciences, La Bouloie, route de Gray, 25030 Besancon Cedex, Paris, France, Mech. Mach. Theory, 17 (1), pp 47-55 (1982) 5 figs, 3 tables, 9 refs
(In French)

Key Words: Rotors, Beams, Timoshenko theory

This paper presents a theoretical and experimental study of the stability of rotors supported by journals having a symmetrical stiffness matrix (oil journals). The model of the shaft is based on Timoshenko's beam theory, and only axisymmetric rotors are considered. The eigenvalue problem associated with a shaft supported by elastic journals is solved. The eigenproblem of a simple rotor (a cylindrical shaft

supporting a thin disc) is solved by a transfer matrix method. The solution of this problem can be extended to more complex rotors. The case of the journals having a more symmetrical stiffness matrix is investigated. Results are compared with those of a symmetrical case and conclusions are drawn.

RECIPROCATING MACHINES

82-1136
Engine Acoustic Impedance Modeled as a Cyclic Series of Passive System Impedances

Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH, Rept. No. AFWAL-TR-80-4203, 134 pp (July 1981)
AD-A103 931

Key Words: Internal combustion engines, Acoustic impedance

A recently proposed two sensor sampling technique was utilized to attain certain acoustic properties of an internal combustion engine. An attempt to define the acoustic source impedance characteristics is of particular interest. The two sensor method of analysis incorporates a digital signal analyzer system to analyze the sensor signals and to calculate incident-reflected acoustic properties. The laboratory method of experimentation includes exposure of the engine to a broadband random noise while performing signal analysis using a transfer function technique. The acoustic source impedance results obtained from this analysis for the engine are then interpreted within a format of passive acoustic systems.

82-1137
The Reduction of Diesel Engine Noise by Close Shielding

J. West
Motor Industry Res. Assn., Watling St., Nuneaton, Warwickshire, CV10 OTU, UK, MIRA Res. Rept. No. 1980/4, 161 pp, 118 figs, 20 tables, 24 refs

Key Words: Diesel engines, Noise reduction, Noise shielding

The lead shielding technique, vibration measurements and a specially designed test rig to simulate the vibration properties of an engine were used to design a number of close shielding systems for two diesel power units. It was found that close shielding offers an alternative palliative, but not cheap means of engine noise control, intermediate between that offered by engine encapsulation and chassis mounted enclosure in the noise reduction provided, but possibly requiring at least as much development work as required for chassis mounted shielding.

METAL WORKING AND FORMING

82-1138
Influence of Machine Suspension and Process Parameters on Noise Emitted from Drop Hammers

S. Vajpayee, M.M. Sadek, and A.C. Hobdell
Univ. of Birmingham, Birmingham, UK, ASME Paper No. 81-WA/NCA-7

Key Words: Forging machinery, Noise generation, Foundations

The noise emitted during forging on a drop hammer supported on a special foundation has been investigated for various configurations of the machine suspension. The tests were carried out at three different levels of input energy for two billet materials and several aspect ratios.

82-1139
Prediction of Acoustic Emission of Impact Forming Machines from Design Drawings

D.T.I. Francis, M.M. Sadek, and S.A. Tobias
Univ. of Birmingham, UK, ASME Paper No. 81-WA/NCA-5

Key Words: Acoustic emission, Forging machinery, Impact response

A method is presented for predicting from design drawings the sound pressure level, the sound power, and directivity of the acoustic emission of structures, based on a numerical solution of the Helmholtz integral equation. The method predicts the acoustic emission for a structure floating free in space, or supported by a reflective surface. The method is applied for predicting the sound emission of a forging machine structure under impulsive loading.

82-1140
Vibration of Wide Band Saw Blades

A.G. Ulsoy and C.D. Mote, Jr.

Dept. of Mech. Engrg. and Appl. Mechanics, Univ. of Michigan, Ann Arbor, MI 48109, J. Engrg. Indus., Trans. ASME, 104 (1), pp 71-78 (Feb 1982) 13 figs, 1 table, 19 refs

Key Words: Saws, Blades, Plates, Membranes (structural members), Flexural vibration, Torsional vibration

The vibration and stability of wide band saw blades is investigated using an axially moving plate model which includes the effect of in-plane stresses upon stiffness. The equation of motion is developed from Hamilton's principle, and approximate solutions are obtained using both the classical Ritz and finite element-Ritz methods. Experimental results from a large-scale band saw are presented and show good agreement with results of the approximate analyses. Analytical results are presented which show the contributions of axial velocity, the wheel support system, blade damping, transverse forces, and in-plane stresses to band vibration and stability. The implications of these results for optimizing the band saw design are also indicated.

82-1141
Band Saw and Circular Saw Vibration and Stability

C.D. Mote, Jr., G.S. Schajer, and W.Z. Wu
Dept. of Mech. Engrg., Univ. of California, Berkeley, CA 94720, Shock Vib. Dig., 14 (2), pp 19-25 (Feb 1982) 25 refs

Key Words: Saws, Circular saws, Reviews

Reviews of band saw vibration and circular saw vibration literature were undertaken in 1978. The modest growth of the literature in these fields since then and some articles not reviewed previously are discussed in this review.

82-1142
Acoustic Diagnosis of a Hydraulic Hammer

S. Vajpayee, M.M. Nigm, and M.M. Sadek
Univ. of Birmingham, Birmingham, UK, ASME Paper No. 81-WA/NCA-8

Key Words: Acoustic techniques, Hydraulic equipment, Hammers, Forging machinery

The paper presents in part the work being carried out, in collaboration with a leading hammer manufacturer, with the aim of developing guidelines based on dynamic and acoustic considerations for rational design of forging machines. It summarizes the results of the first phase of the project concerned with identifying the acoustically weak design areas in the existing hammer.

82-1143
Application of the Regeneration Spectrum Method to Wheel Regenerative Chatter in Grinding

K. Srinivasan
Dept. of Mech. Engrg., Ohio State Univ., Columbus, OH 43210, J. Engrg. Indus., Trans. ASME, 104 (1), pp 46-54 (Feb 1982) 9 figs, 3 tables, 13 refs

Key Words: Machine tools, Wheels, Grinding machinery, Chatter

A convenient stability analysis technique for the approximate computation of wheel regenerative chatter growth rates in cylindrical grinding processes is presented. For such processes, the locations of the roots of the system characteristic equation in the complex plane are simply related to a function of frequency, termed the regeneration spectrum, which is easily determined. The usefulness of the regeneration spectrum method is illustrated by applying it to study the dependence of chatter growth rates on grinding conditions and to evaluate the effectiveness of changes in the machine structure in improving chatter behavior.

STRUCTURAL SYSTEMS

BRIDGES

82-1144
Response of Taut Strip Models to Turbulent Wind

H. Tanaka and A.G. Davenport
Faculty of Science and Engrg., Univ. of Ottawa, Ottawa, Ontario, Canada, ASCE J. Engrg. Mechanics Div., 108 (EM1), pp 33-49 (Feb 1982) 13 figs, 1 table, 21 refs

Key Words: Bridges, Wind-induced excitation, Wind tunnel testing

An experimental investigation was conducted to clarify the fundamental behavior of the proposed taut strip wind tunnel mode' of long span bridge deck systems. The study shows

that this method is a relatively simple and convenient and yet effective method of investigating the aerodynamic behavior of long span bridges with the simulation of natural wind turbulence in laboratory scale. Experimental results are compared with the simple theoretical calculation and some aerodynamic characteristics of bridge response in highly developed turbulent boundary layer flow were observed. Effect of scale of turbulence in particular is found to be significant.

BUILDINGS

(See No. 1233)

FOUNDATIONS

82-1145

Soil-Pile Interaction in Vertical Vibration Induced through a Frictional Interface

T. Akiyoshi
Dept. of Civil Engrg., Kumamoto Univ., Kumamoto 860, Japan, Earthquake Engrg. Struc. Dyn., 10 (1), pp 135-148 (Jan-Feb 1982) 13 figs, 10 refs

Key Words: Interaction: soil-structure, Pile structures

The interaction between a soil layer and an end bearing pile in vertical vibration induced through the frictional interface is theoretically investigated. The pile is assumed to be vertical and elastic, whereas the soil is considered as a linear viscoelastic layer with hysteretic damping. Slip between the pile and the soil is allowed to occur along the frictional interface, in which the hysteretic frictional stress is linearized to permit modal decomposition. Approximate solutions of the pile and the soil for steady-harmonic loads are obtained in closed form by composing the wave modes of the layer. The displacement amplitudes of the pile and the soil, the critical slip force, the stiffness of the pile head, and the modal stiffness contribution of the soil to the pile are evaluated numerically with respect to the ratio of applied force level to the slip stress level and the slenderness ratio, at various frequencies.

82-1146

Torsional Dynamic Response of Solid Media

R. Henke and E.B. Wylie
Exxon Production Res. Co., Houston, TX, ASCE J. Engrg. Mechanics Div., 108 (EM1), pp 73-94 (Feb 1982) 14 figs, 13 refs

Key Words: Torsional response, Foundations, Dynamic response

A new, practical method is proposed for solving the partial differential equations describing the dynamic behavior of either linear elastic or nonlinear inelastic multi-dimensional continua. The ultimate application of the method is the prediction of the dynamic response of foundations to loads having a broad range of intensities. Stresses, particle velocities and partial derivatives are computed numerically for points within the medium giving a detailed description of dynamic response. Since few approximations are introduced, solutions are accurate. The method is applied to the equations describing the axisymmetric torsional behavior of a three-dimensional medium. Multi-dimensional linear and nonlinear torsional solutions are obtained. Examples in which one-dimensional behavior is approximated are discussed.

UNDERGROUND STRUCTURES

(See No. 1330)

HARBORS AND DAMS

82-1147

Hydrodynamic and Foundation Interaction Effects in Frequency Response Functions for Concrete Gravity Dams

A.K. Chopra and S. Gupta
Dept. of Civil Engrg., Univ. of California, Berkeley, CA, Earthquake Engrg. Struc. Dyn., 10 (1), pp 89-106 (Jan-Feb 1982) 21 figs, 1 table, 5 refs

Key Words: Dams, Ground motion, Interaction: structure-foundation, Interaction: structure-fluid

The linear response of idealized dam cross-sections to harmonic horizontal or vertical ground motion is presented for a range of the important system parameters characterizing the properties of the dam, foundation rock and impounded water. Based on these frequency response functions, the separate effects of interaction between the dam and water and interaction between the dam and foundation, and the combined effects of the two sources of interaction, on dynamic response of dams are investigated.

CONSTRUCTION EQUIPMENT

(Also see No. 1179)

82-1148

Travelling Shock Load in Mobile Agricultural Machine Components with Clearance (Fahrstossbelastung spielbehafteter Baugruppen mobiler Landmaschinen)

B. Kritzner

VEB Kombinat Fortschritt Landmaschinen, Neustadt, Germany, Maschinenbautechnik, 30 (11), pp 505-508 (1981) 9 figs, 1 ref

(In German)

Key Words: Agricultural machinery, Surface roughness

Agricultural machinery components which are not rigidly connected to the self-propelled machine might start vibrating independently of the basic machine, resulting in excessive shock loading of the component. A method for reducing this shock loading, without changing the built-in clearance in the components, is presented.

PRESSURE VESSELS

82-1149

An Assessment of the Application of Active Control to Reduce the Seismic Response of Nuclear Power Plants

J.P. Wolf and P.A. Madden

Electrowatt Engrg. Services Ltd., 8022 Zurich, Switzerland, Nucl. Engrg. Des., 66 (3), pp 383-397 (Sept 1981) 17 figs, 5 tables, 14 refs

Key Words: Pressure vessels, Nuclear power plants, Seismic design, Seismic response, Active control

Active control techniques offer the possibility of achieving a single plant design suitable for all seismic regions. Based on the information determined by sensors on the actual state of the dynamic system control forces are fed back acting, e.g. on reactor plant subelements. Limitations of passive systems are examined. The basic concepts of active control are illustrated. The potential for active control of a reactor pressure vessel is demonstrated. A quite simple equivalent dynamic model is shown to be adequate to design the feedback law of the structure which is actually of very high dynamic order. By judicious placement of structural motion sensors and by limitation of the bandwidth of force actuators, destabilizing effects of the higher order structural dynamics (unmodeled for the purpose of control design) are easily controlled in this application. The choice of various controllers for design on the basis of the performance (acceleration of the vessel) versus the control energy are discussed.

POWER PLANTS

(Also see Nos. 1149, 1223, 1224, 1225, 1226, 1227, 1319)

82-1150

Bond Graph Modeling of Nuclear Reactor Dynamics

J.L. Tylee

EG&G Idaho, Inc., Idaho Falls, ID, ASME Paper No. 81-WA/DSC-11

Key Words: Nuclear reactors, Dynamic response, Bond graph technique

A tenth-order linear model of a pressurized water reactor (PWR) is developed using bond graph techniques. The model describes the nuclear heat generation process and the transfer of this heat to the reactor coolant. Comparisons between the calculated model response and test data from a small-scale PWR show the model to be an adequate representation of the actual plant dynamics.

82-1151

Analytical Investigation of a One-Dimensional Homogenized Model for a Pressurized Water Reactor Core

J. Benner and U. Schumann

Kernforschungszentrum Karlsruhe GmbH, Institut f. Reaktorentwicklung, D-7500 Karlsruhe, Fed. Rep. Germany, Nucl. Engrg. Des., 66 (3), pp 413-426 (Sept 1981) 10 figs, 3 tables, 7 refs

Key Words: Interaction: structure-fluid, Nuclear reactor components

A one-dimensional homogenized model for dynamic fluid-structure interaction in a pressurized water reactor core is used to study the influence of the virtual density and spacer's stiffness. The model consists of a linear system of partial differential equations for fluid velocity, rod velocity and pressure. For these equations analytical solutions are deduced for boundary conditions prescribing either periodic wall oscillations or linearly growing wall accelerations from rest. The theoretical model for the virtual density is verified by comparison to an experiment. For zero spacer stiffness, purely acoustic oscillations appear. For positive spacer stiffness, additional oscillations arise with relative rod motions.

82-1152
Seismic Safety Margins Research Program. Phase I. Final Report. Major Structure Response (Project IV)
B.J. Benda, J.J. Johnson, and T.Y. Lo
Lawrence Livermore Natl. Lab., CA, Rept. No. UCRL-53021-VOL-5, 93 pp (Aug 1981)
NUREG/CR-2015-V5

Key Words: Nuclear power plants, Containment structures, Finite element technique, Seismic response

The primary task of the Major Structure Response Project within the Seismic Safety Margins Research Program was to develop detailed finite element models of the Zion Nuclear Power Plant's containment building and auxiliary-fuel-turbine complex. The resulting models served as input to the seismic methodology analysis chain. A second objective of Project IV was to investigate the effects of uncertainty and variability on structural response. Four side studies were conducted. Three of them, briefly summarized in this volume, addressed themselves respectively to an investigation of sources of random variability in the dynamic response of nuclear power plant structures; formulation of a methodology for modeling and evaluating the effects of structural uncertainty on predicted modal characteristics of major nuclear power plant structures and substructures; and a preliminary evaluation of nonlinear responses in shear-wall structures.

82-1153
Seismic Safety Margins Research Program. Phase I. Final Report. Subsystem Response (Project V)
L.C. Shieh, T.Y. Chuang, and W.J. O'Connell
Lawrence Livermore Natl. Lab., CA, Rept. No. UCRL-53021-VOL-6, 60 pp (Oct 1981)
NUREG/CR-2015-V6

Key Words: Nuclear power plants, Nuclear reactor components, Supports, Seismic response

This document reports on the computation of the responses of subsystems, given the input subsystem support motion for components and systems whose failure can lead to an accident sequence (radioactive release), and the results of a sensitivity study undertaken to determine the contributions of the several links in the seismic methodology chain -- seismic input, soil-structure interaction, structure response, and subsystem response -- to the uncertainty in subsystem response.

OFF-SHORE STRUCTURES

82-1154
Earthquake Response of Sea-Based Storage Tanks by a Hybrid Element Method-Theory and Computer Analysis
S.-C. Lee and D.R. Ko
Dynamics Technology, Inc., Torrance, CA, Rept. No. DT-7814-2, NSF/CEE-81026, 214 pp (Mar 1981)
PB82-104993

Key Words: Off-shore structures, Tanks (containers), Underwater structures, Earthquake response, Finite element technique

An effective method for the linear analysis of dynamic response of submerged underwater oil storage tanks to loadings of earthquake excitations is presented. The tank is axisymmetric in shape and has a flexible wall/roof. A general hybrid-finite element solution procedure is formulated, wherein the tank structure, the interior fluids, as well as the near field of the exterior water region, are discretized into a toroidal mesh network. The tank displacement is expressed as a superposition of the first few modes of the structure's free vibration. Contribution from the hydrodynamic interaction to the coupled motion is obtained by solving the Laplace equation with the appropriate boundary conditions, which includes a match to the exterior far-field pressure (analytic) representation to simplify the computational process. The effects of fluids surrounding and inside the tank are studied.

VEHICLE SYSTEMS

GROUND VEHICLES
(Also see Nos. 1178, 1180, 1183, 1297)

82-1155
Data for Validation of Crash Victim Simulator
N.J. DeLeys
Calspan Advanced Technology Ctr., Buffalo, NY, Rept. No. CALSPAN-6197-V-1, DOT-HS-806 049, 422 pp (Aug 1981)
PB82-123720

Key Words: Collision research (automotive), Experimental test data, Anthropomorphic dummies, Crash victim simulation

Replicate 30 MPH sled tests of a 50th percentile male anthropomorphic dummy restrained by a pre-inflated air bag and a

three-point belt restraint were performed to provide data for validating mathematical simulation models of a crash victim. Special instrumentation of the dummy included triaxial accelerometers on the lower arms and 84 photographic targets attached to the dummy to permit measurement of segment motions from analysis of films from six high-speed cameras used to photograph the tests. Normal and tangential loads generated by contact of the dummy with the seat, toeboard, knee bolster and air bag reaction panel were also measured.

82-1156

Field Shock and Vibration Tests of Vehicles

Army Test and Evaluation Command, Aberdeen Proving Ground, MD, Rept. No. TOP-2-2-808, 11 pp (Oct 1, 1981)
AD-A106 358

Key Words: Ground vehicles, Tracked vehicles, Shock tests, Vibration tests, Measurement techniques, Equipment response, Human response

A method of evaluating shock and vibration characteristics of vehicles during operation over selected test courses is described. Procedures are discussed for measuring structural response and response of components, equipment, cargo, and personnel positions. Instrumentation, courses, and guidelines for determining points at which three standardized levels of human exposure are reached and discussed. This material is applicable to wheeled and tracked vehicles.

82-1157

Subjective Response to Traffic Noise Related to Objective Measurements Inside and Outside of Dwellings

C.D. Callow and R. Hedges
Motor Industry Res. Assn., Watling St., Nuneaton, Warwickshire, CV10 OTU, UK, MIRA Res. Rept. No. 1980/3, 52 pp, 28 figs, 12 tables, 7 refs

Key Words: Traffic noise, Noise measurement, Noise reduction

This report is devoted to the question of finding the most cost-effective way of optimizing the control of noise emitted by vehicles in an urban environment. It considers whether it is realistic to predict the noise level inside a residence from the external measured noise emission. It also examines whether subjective preference for internal noise can be adequately predicted solely from external noise measurements, or whether an alternative approach is required.

82-1158

Rail Vehicle Dynamics Model Validation

S.E. Shladover and R.L. Hull
Systems Control, Inc., Palo Alto, CA, Rept. No. FRA/ORD-81/52, 42 pp (Aug 1981)
PB82-116922

Key Words: Railroad trains, Mathematical models, System identification techniques

The validation of mathematical models of rail vehicle dynamics using test data poses a number of difficult problems, which are addressed in this report. Previous attempts to validate rail vehicle models are reviewed critically, and experience gained in validating dynamic models of aircraft and marine vehicles using system identification methods is then applied to the formulation of a general procedure for validating rail vehicle dynamic models. The procedure is outlined, step by step, for application with existing test data and for use as part of a new model validation test program.

82-1159

A Technique to Estimate Lateral Rail Vehicle Forces from Acceleration Measurements

J.K. Kesler and T.-L. Yang
ENSCO, Inc., Springfield, VA, ASME Paper No. 81-WA/DSC-21

Key Words: Interaction: rail-vehicle

The Perturbed Track Test of Locomotives was conducted to support both the Federal Railroad Administration's Track Research Program and the Vehicle/Track Interaction Subtask of the Track/Train Dynamics Program. As a part of this effort a technique to estimate total lateral forces applied to the track by a truck or an axle in a rail vehicle was developed.

82-1160

Tank Car Head Shield Fatigue Performance Study

M.R. Johnson
IIT Research Inst., Chicago, IL, Rept. No. IITRI-T06004, ARBRL-CR-00469, 51 pp (Sept 1981)
AD-A106 071

Key Words: Railroad cars, Tank cars, Protective shields, Impact tests, Fatigue life

The dynamic response of a typical railroad tank car head shield and its attachments was examined during car-coupling

impact tests to determine its expected fatigue performance. The work was based on data obtained on car-coupling impact tests. The test car and one of its head shields were instrumented with transducers to provide a continuous output of strains, forces, and accelerations. The largest strains were measured on the anvil car tests, which was a test where the instrumented car was struck by a moving car. A dynamic finite element analysis was conducted to provide a means for extrapolating experimental strain data to other locations in the head shield structure. The analysis showed that the maximum strains were about twice the maximum measured strains.

82-1161

Nonlinear Stability and Tracking of Rail Passenger Trucks

D. Horak and D.N. Wormley
Bendix Advanced Tech. Ctr., Columbia, MD, ASME Paper No. 81-WA/DSC-8

Key Words: Interaction: rail-wheel, Critical speeds, Railroad cars

An analysis of a rail passenger truck which includes nonlinear wheel/rail geometry and creep forces is formulated for determining truck stability and response to rail alignment irregularities. Digital simulation studies using the analysis illustrate the large amplitude flange to flange response which occurs in operation of a truck below critical speed on a track with significant alignment irregularity, of a truck near critical speed and excited by irregularities, and of a truck operated above critical speed.

SHIPS

82-1162

Dynamic Analysis of Dolphins Subjected to Ship Impact

C.P. Heins and L.Y.-B. Chiu
Inst. for Physical Science and Tech., Civil Engrg. Dept., Univ. of Maryland, College Park, MD 20742, Computers Struc., 15 (1), pp 49-59 (1982) 5 figs, 6 tables, 2 refs

Key Words: Collision research (ships), Computer programs

The protection of bridge piers is an important facet of structural engineering, as without such protection major disasters and fatalities can result. This paper provides the details of a computer program which considers the dynamics of ship/dolphins/soil interaction and the design of dolphins, clusters and platforms or caps.

AIRCRAFT

(Also see Nos. 1178, 1318, 1321, 1322, 1323)

82-1163

Experimental Modal Analysis of the Fuselage Panels of an AERO Commander Aircraft

D. Geisler
Wyle Labs., Inc., Huntsville, AL, Rept. No. NASA-CR-165750, RETP 10568, 164 pp (Sept 1981) N82-10028

Key Words: Aircraft, Panels, Interior noise, Noise reduction, Modal analysis, Natural frequencies, Mode shapes, Modal damping

The reduction of interior noise in light aircraft was investigated with emphasis on the thin fuselage sidewall. The approach used is theoretical and involves modeling of the sidewall panels and stiffeners. Experimental data obtained from tests investigating the effects of mass and stiffness treatments to the sidewalls are presented. The dynamic characteristics of treated panels are contrasted with the untreated sidewall panels using experimental modal analysis techniques. The results include the natural frequencies, modal damping, and mode shapes of selected panels. Frequency response functions, data relating to the global fuselage response, and acoustic response are also presented.

82-1164

Resonant Whirling of Aircraft Propeller-Engine Systems

S.H. Crandall and J. Dugundji
Dept. of Mech. Engrg., Massachusetts Inst. of Tech., Cambridge, MA 02139, J. Appl. Mechanics, Trans. ASME, 48 (4), pp 929-935 (Dec 1981) 10 figs, 5 refs

Key Words: Aircraft, Propeller blades, Blades, Resonant response, Whirling

At a critical speed, a light aircraft can experience severe vibrations in steady flight in which the propeller blades vibrate at one frequency while the engine block vibrates at a lower frequency. A model is presented which explains this phenomenon. A three-bladed propeller-engine system is considered to have six rigid-body degrees of freedom plus

six blade vibration degrees of freedom. This system is analyzed and simplified by introducing a constraint based on observation of the flight phenomenon. Multiblade coordinates are introduced and a linear eigenvalue problem is derived which describes whirling motions of the engine coupled to progressive waves of blade deformation which circle the propeller disk. These whirling motions are excited by harmonics of the transverse forces on the engine due to the explosive gas pressures in the cylinders. The effects of varying the propeller blade pitch angle are studied and a high-speed instability mechanism is examined.

82-1165

Aircraft Gas Turbine Engines: Noise Reduction and Vibration Control. January, 1973 - October, 1981 (Citations from Information Services in Mechanical Engineering Data Base)

NTIS, Springfield, VA, Rept. for Jan 1973 - Oct 1981, 154 pp (Oct 1981)
PB82-853615

Key Words: Aircraft noise, Engine noise, Noise reduction

The design of aircraft gas turbine engines is discussed in the cited reports in terms of noise reduction and vibration control. The aerodynamics of inlet design is presented for several types of engine applications and includes turboprop as well as vertical takeoff and land aircraft.

82-1166

F-16 Flutter Suppression System Investigation Feasibility Study and Wind Tunnel Tests

R.P. Peloubet, Jr., R.L. Haller, and R.M. Bolding
General Dynamics, Fort Worth, TX, J. Aircraft, 19 (2), pp 169-175 (Feb 1982) 11 figs, 3 tables, 9 refs

Key Words: Aircraft wings, Wing stores, Flutter, Active flutter control, Wind tunnel testing

A study was conducted to determine the feasibility of employing active controls on the F-16 to suppress wing-store flutter for several external store configurations. It was determined that the existing flaperons, with modifications to the integrated servoactuators, were effective in suppressing flutter. The F-16 flutter model was tested with active flaperons. Open-loop frequency response functions (FRF's) were successfully measured in the wind tunnel environment both with the feedback loop physically opened and with the loop closed. These measurements provided guidance in the selection of sensor locations and feedback control laws to suppress flutter. Control law variations were made to obtain the desired FRF characteristics. A 100% increase in dynamic pressure above the flutter dynamic pressure was demonstrated.

82-1167

A Method for Determination of the Aeroelastic Behavior of Aircraft with Active Control Systems

R. Freymann
Deutsche Forschungs- und Versuchsanstalt feur Luft- und Raumfahrt e.V., Goettingen, Fed. Rep. Germany, Rept. No. DFVLR-FB-81-05, 128 pp (Feb 1981)
N82-10047
(In German. To be announced as Transl. ESA-TT-719)

Key Words: Aircraft, Active control, Aeroelasticity, Aerodynamic stability

An analytical method for the performance of dynamic calculations on servocontrolled aircraft, based on an extended formulation of the generalized aeroelastic equations is presented. The additional parameters introduced in the extended equations of motion are determined experimentally in a ground vibration test performed on a real aircraft structure as well as with help from an experimental-analytical method for determination of the transfer functions of the hydraulic actuators. The elaborated method is shown satisfactory by comparison of measured and calculated data resulting from investigations performed on a model wing structure with a rudder driven by a hydraulic actuator.

82-1168

Resonance Tests on a Piper PA-32R Tailplane Before and After Damage

A. Goldman and B. Quinn
Aeronautical Res. Labs., Melbourne, Australia, Rept. No. ARL/STRUC-TM-328, 16 pp (Apr 1981)
AD-A106 273

Key Words: Aircraft, Resonance tests

Investigations were carried out on the tailplane of a Piper PA-32R aircraft to determine the effect of damage, in the form of a split in the underside skin, on the modes of vibration of the tailplane. Details and results of the investigations are described.

82-1169

System Identification of the Longitudinal Motion of the DFVLR HFB 320 Research Aircraft with Particular Consideration of Control Surface Effectiveness

O. Rix

European Space Agency, Paris, France, Rept. No. ESA-TT-666, 55 pp (Apr 1981) (English trans. of "Systemidentifizierung des Dfvlr-Forschungsflugzeugs Hfb 320 in der Laengsbewegung mit besonderer Beruecksichtigung der Steuerflaechenwirksamkeit" Rept. Dfvlr-Mitt-79-66, Dfvlr, Brunswick, July 1979) N82-10045

Key Words: Aircraft, Longitudinal response, System identification

Analysis of the longitudinal motion of the DFVLR HFB-320 research aircraft by means of a maximum likelihood method is described. The control surface effectiveness of separately or simultaneously deflected DLC flaps and spoilers was determined. The flight test technique, and the influence of different mathematical models on the results obtained, are illustrated and discussed.

82-1170

Investigation of the Crash Impact Chracteristics of Composite Airframe Structures

J.D. Cronkhite, T.J. Haas, R. Winter, and G.T. Singley, III

Bell Helicopter Textron, Fort Worth, TX, J. Amer. Helicopter Soc., 26 (4), pp 52-63 (Oct 1981) 21 figs, 41 refs

Key Words: Crash research (aircraft), Airframes, Helicopters, Composite materials

The results of a comprehensive review of the field of crash impact characteristics of advanced troop transport helicopter airframe structures constructed of composite materials is presented. Currently available information was surveyed on: the crash impact behavior of composite materials, the analytical tools for design of crashworthy airframe structures, and the airframe structure crashworthiness design criteria. Information on the crash impact behavior of composite materials was found to be limited. However, some interesting studies were found, including an automotive study which showed that by innovative design, composite materials could function efficiently as energy absorbers to reduce crash impact loads.

82-1171

An Investigation of a Stoppable Helicopter Rotor with Circulation Control

J.D. Ballard, J.L. Mccloud, III, and T.J. Forsyth

Rept. No. NASA-TM-81218, A-8278, 372 pp (Aug 1980)
N82-10030

Key Words: Helicopters, Rotors, Stability, Wind tunnel testing

A stoppable helicopter rotor with circulation control was investigated in the Ames 40 by 80 foot wind tunnel. The model was tested as a rotating wing, a fixed wing, and during transition start/stop sequences. The capability of the model's control system to maintain pitch and roll moment balance during the start/stop sequence, the ability of the blades to withstand the start/stop loads, the adequacy of the control system to maintain balance in the helicopter mode, and the control system capabilities in the fixed-wind mode were assessed. Time-history data of several start/stop sequences of the X-wing rotor, and the steady-state data relating to the model as both a rotor and as a fixed-wing aircraft are presented. In addition, stability data are presented which were acquired during open-loop and closed-loop tests of the hub moment feedback control system.

82-1172

Fabrication Methodology for a Composite Main Rotor Blade for the YAH-64 Advanced Attack Helicopter

R.L. Kiraly, H.T. Lund, S.S. Yao, and J. Tutka

Hughes Helicopters, Inc., Culver City, CA, J. Amer. Helicopter Soc., 26 (4), pp 31-35 (Oct 1981) 15 figs, 2 refs (Pres. at Natl. Specialist's Mtg., "Rotor System Design" of the American Helicopter Soc., Philadelphia, PA, Oct 22-24, 1980)

Key Words: Helicopters, Propeller blades, Composite materials

The fabrication methodology for a composite main rotor blade for the YAH-64 Advanced Attack helicopter (AAH) is presented. The design approach and criteria utilized in achieving a composite blade which is dynamically compatible with, and geometrically similar to, the AAH metal blade are discussed in detail. The material selection criteria and application to structural and non-structural components are also discussed. Application of the wet filament winding co-cure process selected as the method of fabrication to achieve the structural and dynamical compatibility of the subject composite main rotor blade is the major thrust of this paper.

MISSILES AND SPACECRAFT

(Also see Nos. 1282, 1283, 1284, 1286)

82-1173

Parameter Analytical Studies for the Nonlinear Dynamic Response of the Tile/Pad Space Shuttle Thermal Protection System

H. Edighoffer
Re-entry and Environmental Systems Div., General Electric Co., Philadelphia, PA, Rept. No. NASA-CR-165707, 71 pp (Oct 28, 1981)
N82-10101

Key Words: Space shuttles, Skin (structural members), Protective shields, Thermal insulation, Resonant frequencies, Periodic response, Random response, Computer programs

The studies examined for imposed sinusoidal and random motions of the shuttle skin and/or applied tile pressure. Studies are performed using the computer code DYNOTA which takes into account the highly nonlinear stiffening hysteresis and viscous behavior of the pad joining the tile to the shuttle skin. Where available, experimental data are used to confirm the validity of the analysis. Both analytical and experimental studies reveal that the system resonant frequency is very high for low amplitude oscillations but decreases rapidly to a minimum value with increasing amplitude.

82-1174

Dynamic Analysis of Beam-Rider Missile Performance

J. Shinar, E. Besner, and Y. Rotzstein
Dept. of Aeronautical Engrg., Technion -- Israel Inst. of Tech., Haifa, Israel, Israel J. Tech., 19 (3), pp 81-88 (1981) 6 figs, 16 refs

Key Words: Missiles, Dynamic response

Performance of a point defense beam-rider missile system with linearized trajectory equations is analyzed taking into account the dynamics of the guidance loop. It is shown that adding a lead term, proportional to the line-of-sight turn rate, to the guidance command improves the system performance against maneuvering targets at the expense of increased noise sensitivity. A formal solution to the problem of optimal beam-rider missile avoidance is also presented indicating a "bang-bang" type evasive maneuver.

82-1175

Analytical Determination of Dynamic Stability Parameters

C.P. Schneider
Messerschmitt-Boelkow-Blohm GmbH, Munich, Fed. Rept. Germany, Rept. No. MBB-UA-522/80 (OE), 41 pp (1980)
N81-33226

Key Words: Missile components, Dynamic stability, Prediction techniques

Prediction methods and results are grouped according to those which lead to expressions of the derivatives in closed forms, such as slender body theory, and those which require numerical procedures. Derivatives of longitudinal stability are discussed in detail. For subsonic flow conditions, derivatives of missile components were investigated at high angles of attack and a simplified, quasisteady treatment is given for rigid missile components under steady flight conditions. The possibility of obtaining stability derivatives of bodies at high angles of attack in supersonic flight is discussed.

82-1176

Dynamic Flight Load Charts for Spacecraft Design

C. Stavrinidis
European Space Agency, Postbus 299, 2200 AG Noordwijk ZH, The Netherlands, Recent Advances in Space Structure Design -- Verification Techniques, Proc. Presentation held at ESTEC, Noordwijk, The Netherlands, April 27-28, 1981, European Space Agency ESA SP 1036, Oct 1981, pp 27-34, 4 figs, 2 tables, 21 refs

Key Words: Spacecraft, Launching response, Design techniques

Early in the design and configuration phase of a spacecraft designers need information on dynamic loads which incorporate the effects of launcher/spacecraft interaction. The general properties of loaded and unloaded modal formulations are presented in a way which permits the setting up of spacecraft design load charts taking into consideration the launcher/spacecraft interaction. Effective grouping of relevant governing dynamic parameters produces an accurate process which will reduce or limit the transient launcher/spacecraft coupled analyses performed by the launcher authority.

BIOLOGICAL SYSTEMS

HUMAN

82-1177
Community Noise Attitudinal Survey Guidelines
Inst. for Survey Research, Temple Univ., Philadelphia, PA, 147 pp (July 1981)
PB81-244295

Key Words: Urban noise, Noise reduction, Human response

This report provides a procedure for implementing a survey of people's attitudes toward noise. An attitudinal questionnaire to be administered to city residents is provided. The survey technique to be employed is telephone interviewing. Also provided are the procedures for using a probability sampling technique to estimate the characteristics of the population. A method for analyzing the collected data is discussed.

82-1178
Direct Comparison of Community Response to Road Traffic Noise and to Aircraft Noise
F.L. Hall, S.E. Birnie, S.M. Taylor, and J.E. Palmer
Dept. of Civil Engrg. and Dept. of Geography, McMaster Univ., Hamilton, Ontario, Canada, J. Acoust. Soc. Amer., 70 (6), pp 1690-1698 (Dec 1981) 5 figs, 8 tables, 23 refs

Key Words: Aircraft noise, Traffic noise, Human response

Data collected recently around Toronto International Airport provide a direct comparison of response to two sources, based on 673 interviews of persons exposed to a variety of levels of both aircraft and road traffic noise. The results of that analysis do not support the assumption that response to these two noise sources is the same. A greater percentage of the sample is highly annoyed by aircraft noise than by road traffic noise. Possible reasons for this contradiction of the results of a previous synthesis of noise surveys are discussed.

82-1179
Detrimental Impacts of Vibration Exposure in Industrial-Occupational Environments
D.P. Garg
Duke Univ., Durham, NC, ASME Paper No. 81-WA/Saf-5

Key Words: Human response, Vibration excitation, Agricultural machinery, Tractors, Earth handling equipment

The modeling and measuring approach of standing humans subjected to vibratory inputs is presented, followed by a discussion of vibration exposure of seated subjects such as tractor and earth-moving machinery operators. Protective measures and design recommendations are presented, where applicable, to mitigate the undesirable influence of vibration exposure.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS
(Also see No. 1329)

82-1180
Development of Quiet Low Back Pressure Exhaust Silencers on Two Saloon Cars Using a Performance Prediction Computer Program
J.N. Devlukia
Motor Industry Res. Assn., Watling St., Nuneaton, Warwickshire, CV10 OTU, UK, MIRA Res. Rept. No. 1980/2, 101 pp, 57 figs, 6 tables, 27 refs

Key Words: Silencers, Railroad cars, Computer-aided techniques

This report describes the development of low back pressure, all reactive, exhaust silencer systems to assess the extent to which fuel consumption could be reduced, power output increased and silencer performance improved and rationalized by an experimental approach aided by a computer performance prediction program. Although the design targets were substantially met, the computer aided design procedure proved to be of only limited success and much more basic research is required before drawing board design of exhaust silencers becomes a practicality.

82-1181
Reduction of Structural Vibration by a Dynamic Absorber
J.M. Williams

Royal Aircraft Establishment, Farnborough, UK, Rept. No. RAE-TM-AERO-1881, DRIC-BR-77778, 27 pp (Dec 1980)
AD-A104 139

Key Words: Dynamic vibration absorption (equipment), Plates

Described is the transmission of vibration in dynamical systems, and a particular example is studied in detail. This consists of two freely supported elastic plates, connected by a rigid link. It is shown that the addition of a dynamic absorber to such a system can significantly attenuate the transmitted velocities over a chosen narrow band of frequency.

82-1182
Development of Nonlinear Frequency and Load Dependent Models for Snubbers
M.A. Pickett and J.R. Gartner
Univ. of Connecticut, Storrs, CT, ASME Paper No. 81-WA/PVP-3

Key Words: Snubbers, Piping systems

Snubbers are used in many piping systems where stresses due to potentially damaging transients must be limited. Snubber models are developed herein based on the inherent velocity-sensitive or acceleration-sensitive characteristics of the respective devices. The models are used to determine the conditions necessary for snubber actuation and to analyze the effect that variations in model parameters have on piping system response. The models are applied to a single span piping system.

82-1183
Rail Vehicle Active Suspensions for Lateral Ride and Stability Improvement
G.W. Celniker and J.K. Hedrick
Schlumberger Well Services, Houston, TX, ASME Paper No. 81-WA/DSC-14

Key Words: Suspension systems (vehicles), Active control, Railroad cars

The potential performance benefits of simple, low power active elements in the lateral secondary, between the truck and carbody is investigated analytically by parametric studies utilizing 15 degree-of-freedom lateral model subject to alignment and cross-level inputs. It is shown that significant improvements in ride quality can be obtained at current operating speeds by using less than 3 kW per truck by sensing lateral carbody accelerations and utilizing lateral force actuators between the truck and carbody.

TIRES AND WHEELS
(Also see No. 1313)

82-1184
Describing Function Analysis of Nonlinear Nose Gear Shimmy
T.D. Burton
Washington State Univ., Pullman, WA, ASME Paper No. 81-WA/DSC-20

Key Words: Gears, Wheel shimmy

The design of shimmy free nose landing gear is complicated by the action of the gear hydraulic steering system. During shimmy the steering system pressure response results in loads on the gear which are highly nonlinear functions of gear motion. In order to obviate the need for extensive numerical work to analyze gear stability, the describing function method has been used to linearize the steering system response, enabling the stability to be analyzed using linear system techniques.

82-1185
Analytical Model of the Truck Tire Vibration Sound Mechanism
R.F. Keltie
Ctr. for Sound and Vib., Mech. and Aerospace Engrg. Dept., North Carolina State Univ., P.O. Box 5801, Raleigh, NC 27650, J. Acoust. Soc. Amer., 71 (2), pp 359-367 (Feb 1982) 12 figs, 1 table, 12 refs

Key Words: Tires, Truck tires, Cylindrical shells, Damping effects

A theoretical model is developed to describe the sound radiation by the surface vibration of in-service truck tires. The tire is modeled as an infinitely long incomplete circular cylindrical shell. The effects of inflation pressure and structural damping are included. The normal displacement, velocity, and acceleration resulting from a fluctuating load are determined using Flugge's thin shell theory. Through numerical integration of the surface acoustic intensity, the radiated sound power is calculated as a function of damping, inflation

pressure, and bending stiffness. Results indicate that the forced acoustic response is insensitive to small changes in the material loss factor and the bending stiffness. The inflation-induced membrane stresses determine the acoustic response character to a large extent and total neglect of the bending stiffness does not seriously affect the calculated sound power. The basic sound radiation mechanism is shown to be the damped progressive wave field on the structure in the vicinity of the applied force. The results indicate that the potential sound reduction might best be approached through study of the tire loading and vibration response mechanisms.

BLADES

82-1186
Prediction of Blade-Vortex Interaction Noise from Measured Blade Pressure

Y. Nakamura
NASA Ames Res. Ctr., Moffett Field, CA, Rept. No. NASA-TM-81320, A-8692, 22 pp (Sept 1981)
N81-33157

Key Words: Blades, Propeller blades, Noise prediction

The impulsive nature of noise due to the interaction of a rotor blade with a tip vortex is studied. The time signature of this noise is calculated theoretically based on the measured blade surface pressure fluctuation of an operational load survey rotor in slow descending flight and is compared with the simultaneous microphone measurement. Particularly, the physical understanding of the characteristic features of a waveform is extensively studied in order to understand the generating mechanism and to identify the important parameters. The interaction trajectory of a tip vortex on an acoustic planform is shown to be a very important parameter for the impulsive shape of the noise. The unsteady nature of the pressure distribution at the very leading edge is also important to the pulse shape.

BEARINGS

82-1187
Basic Design Data of Aerodynamic Resilient Bearings for Small Turbo Engines (Grundlagen zur Auslegung aerodynamischer Federlager für kleine Turbomaschinen)

J. Glienicke, M. Ehinger, and H. Hunger
Inst. f. Maschinenkonstruktionslehre der Universitat Karlsruhe, Kaiserstrasse 12, D-7500 Karlsruhe, Germany, MTZ Motortech. Z., 42 (12), pp 531-536 (Dec 1981) 12 figs, 1 table, 7 refs
(In German)

Key Words: Bearings, Turbine engines

Aerodynamic bearings can be used under extreme operating conditions, with extremely high circumferential speeds, and at both extremely low and extremely high operating temperatures. Moreover, with an aerodynamic bearing there are no sealing problems since it draws its lubricant from the working medium. Applications include rapidly rotating shafts of any kind, such as in small gas turbines and exhaust-gas turbochargers and in other small turboengines. Based on the fundamental equations of aerodynamic bearing theory a method is developed to determine the static and dynamic bearing characteristic curves and is applied to the tilting-pad, "Garrett" and multi-wedged resilient bearings.

82-1188
Statistical Model of Thrust Rolling Bearings as Kinematic Vibration Exciters

B.-Z. Sandler
Dept. of Mech. Engrg., Ben-Gurion Univ. of the Negev, Beer Sheva, Israel, Israel J. Tech., 19 (1-2), pp 65-70 (1981) 7 figs, 2 refs

Key Words: Bearings, Thrust bearings, Vibration excitation, Statistical analysis

This paper deals with an attempt to express statistically the kinematic excitability of thrust rolling bearings. The components of the excitation spectrum are described and the spectral density of the kinematic excitation of the above-mentioned bearings is expressed in terms of specific assumptions. An experimental example is described on the basis of typical thrust bearings.

82-1189
Theory and Practice of Self-Lubricated, Oscillatory Bearings for High-Vacuum Applications, Part I - Selection of the Self-Lubricating Composite Retainer Material

M.N. Gardos
Hughes Aircraft Co., Culver City, CA 90230, Lubric. Engrg., 37 (11), pp 641-656 (Nov 1981) 7 figs, 6 tables, 17 refs

Key Words: Bearings, Vibrating structures, Composite materials, Wear

A seven-year, interdisciplinary effort was recently completed successfully in developing self-lubricated bearings capable of continuous oscillatory motion for the equivalent of 5 + years in high vacuum, while maintaining arc-second-alignment accuracy of precision gimbal-pointing mechanisms. This paper, the first of a two-part series, describes the selection method for the PTFE-based, polymeric self-lubricating composite, which was eventually used as the lubricative retainer. The method consisted of statistical matrices of oscillatory sliding- and rolling-element friction and wear tests completed with commercially available and special test apparatus. Regression analysis of the data led to parametric wear equations. These wear equations revealed quantitative wear behavior differences between two seemingly similar composites. Coupled with extensive analysis of the worn bearing surfaces, they helped uncover the fundamental causes of these differences and clarified the parametric influences on wear and friction. The resulting ability to predict composite wear accurately as nonlinear functions of load, speed and time, and as a function of atmosphere, offers the first promising, semiempirical approach to accelerated testing of self-lubricated bearings, as indicated by the bearing test results of the second paper of this series.

82-1190

Theory and Practice of Self-Lubricated, Oscillatory Bearings for High-Vacuum Applications, Part II -- Accelerated Life Tests and Analysis of Bearings

C.R. Meeks
Hughes Aircraft Co., Culver City, CA 90230, Lubr. Engrg., 37 (11), pp 657-667 (Nov 1981) 11 figs, 2 tables, 6 refs

Key Words: Bearings, Vibrating structures, Wear

A seven-year, interdisciplinary effort was recently completed to develop self-lubricating bearings capable of continuous oscillatory motion for 5 + years in high vacuum while maintaining arc-second-alignment accuracy of precision gimbal-pointing mechanisms. This paper, the second in a two-part series, describes a series of accelerated vacuum life tests, designed to monitor and map the performance characteristics of the dry-lubricated bearings throughout their lifetime of service by continuous monitoring of friction torque and periodic evaluation of the effects of temperature cycling and radial temperature gradients. Operating stresses were accurately controlled by initial preloading and through accurate control of radial thermal gradients. Operating loads and stresses were optimized by theoretical analysis and bearing wear and performance were compared with theoretical predictions. Twenty-two bearing specimens were tested for periods up to 15,000 hours in high vacuum and operated successfully for up to 31 x 10^9 degrees of oscillatory travel. Friction, wear and bearing torque test data, combined with optical-scanning electron microscopic and x-ray energy dispersive spectroscopic examination of the test bearing components, were used to develop a theoretical model of wear behavior. The ultimate life capability of this system was estimated using the theoretical model and extrapolation of empirically determined wear rates.

82-1191

Stability and Unbalance Response of Large Turbine Bearings

N. Abdul-Wahed, D. Nicolas, and M.T. Pascal
Laboratoire de Mecanique des Contacts, Institut National des Sciences, Appliquees de Lyon 69621 Villeurbanne, France, J. Lubric. Tech., Trans. ASME, 104 (1), pp 66-75 (Jan 1982) 17 figs, 4 tables, 36 refs

Key Words: Bearings, Turbine components, Unbalanced mass response

Different bearing types frequently used in turbine practice are studied for both stability and unbalance response by linear and nonlinear analysis. The bearing configurations studied are: plain circular, three-axial groove, elliptical, three-lobe, and the three-pocket type. For the film force calculation, the Reynolds equation was solved by finite difference techniques using the effective viscosity concept. The bearing unbalance response was investigated for two values of out-of-balance loads: small unbalance which corresponds to an inaccurate balancing of rotors and large unbalance representative of some emergency conditions in turbomachines (blade loss, for example). In the nonlinear analysis, the effect of energy dissipation in the film by the dynamic motion on the effective viscosity was investigated. The principal results show that all parameters which stabilize the bearing increase the bearing sensitivity to large unbalances. The bearings are ranked as follows in the order of increasing resistance to unbalance loading: three pockets, three-axial groove, offset three lobe, elliptic, circular. A quite different classification was obtained for the stability characteristics where the circular bearing was one of the least stable bearings.

82-1192

Spherical Roller Bearing Analysis

R.J. Kleckner and J. Pirvics
SKF Industries, Inc., King of Prussia, PA, J. Lubric. Tech., Trans. ASME, 104 (1), pp 99-108 (Jan 1982) 14 figs, 2 tables, 34 refs

Key Words: Bearings, Roller bearings, Computer programs, Temperature effects

This paper documents the analytic foundation and software architecture for the computerized mathematical simulation of spherical roller bearing behavior, with emphasis on the mechanical aspects of bearing operation at a given temperature. The resulting software permits isothermal investigation of spherical bearing performance under axial, radial, or combined loading. The analysis considers elastohydrodynamic and hydrodynamic lubrication loads, roller tilt and skew, roller speeds, and mounting fits. Sample problems illustrating program use are presented.

FASTENERS

(See No. 1232)

LINKAGES

82-1193

Dynamic Response of an Electric Motor-Linkage System During Startup

A. Myklebust
Mech. Engrg. Dept., Florida Atlantic Univ., Boca Raton, FL 33431, J. Mech. Des., Trans. ASME, 104 (1), pp 137-142 (Jan 1982) 8 figs, 7 refs

Key Words: Linkages, Four bar mechanisms, Motors

The dynamic response of a d-c separately excited motor coupled to a general four-bar linkage is investigated. The analysis is formulated by the principles of analytical mechanics resulting in first order equations with first order constraints and undetermined multipliers with their derivatives. The constraint equations are based on the velocity ratio equations rather than the commonly used loop equations. An example is presented.

SEALS

82-1194

Aerodynamic Lateral Forces in Labyrinth Seals (Stromungsbedingte Querkräfte in Labyrinthdichtungen)

H. Benckert
Institut f. Thermische Stromungsmaschinen und Maschinenlaboratorium der Universitat Stuttgart, West Germany, MTZ Motortech. Z., 43 (1), pp 11-19 (Jan 1982) 18 figs, 24 refs
(In German)

Key Words: Seals, Rotors, Self-excited vibrations, Fluid-induced excitation, Turbomachinery

Self-excited rotor vibrations which are a function of output are being increasingly observed in high-performance turbomachinery, in particular high-pressure compressors. A possible source of these rotor instabilities lies in the dynamic behavior of the labyrinth seals. Information on flow induced spring constants in these types of machines is necessary to achieve a more effective vibration analysis. The investigations presented in this paper deal with the flow induced lateral forces of eccentric-mode labyrinth seals, which are acting perpendicular to the deflection plane of the rotor. The discussion includes the effects of operational conditions on the spring characteristics of these components, such as differential pressure, speed, inlet flow conditions and the geometry of the labyrinth seals. Measured and calculated lateral forces are compared for an interlocking labyrinth. The utilization of the investigations is explained.

CAMS

82-1195

The Effect of Cam Profile Errors and System Flexibility on Cam Mechanism Output

H.R. Kim and W.R. Newcombe
Dept. of Mech. Engrg., McMaster Univ., Hamilton, Ontario, Canada L8S 4L7, Mech. Mach. Theory, 17 (1), pp 57-72 (1982) 18 figs, 17 refs

Key Words: Cams, Initial deformation effects, Simulation

An investigation of the effects of machining errors in the contact surfaces of a cam mechanism together with all possible system flexibility errors is carried out by simulation. An 11 degree of freedom dynamic model of a cam follower system including its drive system was selected, and the dynamic simulation is combined with a stochastic simulation of the random nature of the machining tolerances which have a considerable effect on the actual output. Jump phenomena, the preloading of the retaining spring, variations in angular velocity, characteristics of the various motion curves, flexibility of the various components, non-roundness of cam shaft bearings, non-concentricity of the base circle and machining tolerance on both cam profile and follower are all taken into account, and an analytical method to calculate the spring constant between cam and follower consider-

ing Hertzian contact is developed. The lengthy simulation program is handled on a mini-computer by utilizing suitable numerical methods and overlay techniques resulting in a continuous simulation of the effects of all input errors in a cam-mechanism. The effects of tolerance and flexibility errors are examined separately as well as in combination.

82-1196

Optimization of Cam-Follower Systems with Kinematic and Dynamic Constraints

N. Berzak

Dept. of Mech. Engrg., Ben-Gurion Univ., Beer-Sheva, Israel, J. Mech. Des., Trans. ASME, 104 (1), pp 29-33 (Jan 1982) 5 figs, 1 table, 9 refs

Key Words: Cam followers, Optimization

A general method for obtaining the optimum design of a cam-follower system is presented. This method, developed for polynomial output motions which satisfy prescribed terminal conditions, includes performance criteria related to kinematic, as well as dynamic properties of the system. The output motion and the performance coefficients are expressed as functions of independent parameters. Using a linear sum of the weighted performance coefficients, the optimum design is obtained by scanning a suitable family of polynomial output motions. The theory is illustrated by numerical examples for four-term polynomial output motions.

82-1197

Analysis and Synthesis of Mechanical Error in Cam-Follower Systems

S.S. Rao and S.S. Gavane

Dept. of Mech. Engrg., Indian Inst. of Tech., Kanpur, India, J. Mech. Des., Trans. ASME, 104 (1), pp 52-62 (Jan 1982) 6 figs, 6 tables, 11 refs

Key Words: Cam followers, Error analysis, Initial deformation effects, Probability theory

A method of evaluating the mechanical error in the kinematic and dynamic response of cam-follower systems is presented based on probability principles. The error is analyzed for the three-sigma band of confidence level. A synthesis procedure, using nonlinear programming techniques, of distributing tolerances on geometrical and other system parameters is discussed. The objective of the synthesis problem is to minimize a measure of the manufacturing cost for specified maximum allowable error in the kinematic or dynamic response of the cam-follower system. The application of analysis and synthesis procedures is demonstrated with reference to a disc cam with translating roller follower.

STRUCTURAL COMPONENTS

STRINGS AND ROPES

82-1198

Dynamic Behavior of a Moving Belt Supported on Elastic Foundation

R.B. Bhat, G.D. Xistris, and T.S. Sankar

Dept. of Mech. Engrg., Concordia Univ., Montreal, Quebec, Canada, J. Mech. Des., Trans. ASME, 104 (1), pp 143-147 (Jan 1982) 10 figs, 1 table, 8 refs

Key Words: Belts (moving), Elastic foundations, Moving strips, Flexural vibration

The dynamic behavior of a belt moving on an elastic foundation and supported on two pulleys at the ends is investigated. The problem is formulated to include the nonlinear terms arising from large amplitude oscillations as well as material damping and the variation in tension along the belt. The differential equation of motion is solved employing numerical techniques, and the spatial response variations with time are presented graphically for different belt velocities. These results indicate that in the absence of damping, the system is unstable for any belt velocity larger than the wave velocity in the belt material. The results are useful in investigating the stability of large continuous conveyor systems supported on elastic foundations.

CABLES

(Also see No. 1287)

82-1199

Explicit Analysis of Cables and Cable Network Structures

G.D. Stefanou

School of Engrg., Univ. of Patras, Greece, Israel J. Tech., 19 (3), pp 81-88 (1981) 6 figs, 16 refs

Key Words: Cables, Prestressed structures, Dynamic relaxation

The work reported herein describes briefly a numerical procedure in a form suitable for dynamic and static analysis of tension cables and cable network structures. The method is based on Dynamic Relaxation (DR), proposed by Day (1965). The analysis may be used to determine pretension geometry and behavior under static and dynamic loading, taking into account material and geometric nonlinearity. The theoretical background of the method is briefly outlined and the mathematical expressions derived in general form. The application of DR to solutions based on both finite element and finite difference is also presented. Analytical results obtained by an application of DR for a flat net are compared with numerical predictions by nonlinear deformation theory.

BARS AND RODS

82-1200
Member Initial Curvature Effects on the Elastic Slider-Crank Mechanism Response

M. Badlani and A. Midha
O'Donnell and Associates, Inc., Pittsburgh, PA 15236, J. Mech. Des., Trans. ASME, 104 (1), pp 159-167 (Jan 1982) 10 figs, 26 refs

Key Words: Rods, Curved rods, Slider crank mechanism, Initial deformation effects, Periodic response, Transient response

Parametric vibration of initially curved columns loaded by axial-periodic loads has received considerable attention, concluding that regions of instability exist and that excitation frequencies less than the natural frequency of the principal resonance may occur. Recent publications have cautioned against the use of curved members in machines designed for precise operation, suggesting a detrimental coupling of the longitudinal and transverse deformations. In this work, the dynamic behavior of a slider-crank mechanism with an initially curved connecting rod is investigated. Governing equations of motion are developed using the Euler-Bernoulli beam theory. Both steady-state and transient solutions are determined, and compared with those obtained for the mechanism possessing a geometrically perfect (straight) connecting rod. A very small initial curvature is shown to cause a significantly greater steady-state response. The magnification in its transient response is shown to be even greater than that due to a straight connecting rod. Additionally, an excitation frequency less than the natural frequency is also shown to occur.

BEAMS

(Also see Nos. 1135, 1232)

82-1201
Vibration, Damping, and Acoustic Radiation Due to Transient Excitation of Structures

A. Akay
Wayne State Univ., Detroit, MI, ASME Paper No. 81-WA/NCA-9

Key Words: Beams, Flexural vibration, Transient excitation, Sound propagation, Damping effects

An analytical relationship is developed relating the excitation force to vibrational energy of an object and to the resultant acoustic radiation in systems excited by impacts. Effects of structural and acoustic damping on the transverse vibrations of an impacted finite beam are shown analytically. The normal mode analysis used here can readily be extended to the longitudinal vibrations of bars and transverse plate vibrations due to transient excitations.

82-1202
Transverse Vibrations of Beams, Exact Versus Approximate Solutions

J.R. Hutchinson
Dept. of Civil Engrg., Univ. of California, Davis, CA 95616, J. Appl. Mechanics, Trans. ASME, 48 (4), pp 923-928 (Dec 1981) 6 figs, 3 tables, 20 refs

Key Words: Beams, Flexural vibration, Natural frequencies, Timoshenko theory

An exact solution for the natural frequencies of vibration of a finite length free-free beam with a circular cross section is found and compared to approximate solutions. This exact solution is a series solution of the general linear elasticity equations which converges to correct natural frequencies. Correctness of the frequencies is established by comparison to previous experiments. Comparison of the exact to approximate solutions is made with the Pochhammer-Chree approximation, the Timoshenko beam approximation and the Pickett approximation. The comparisons clearly show the range of applicability of the approximate methods as well as their accuracy. The correct shear coefficient for use in the Timoshenko beam approximation is investigated and conclusions which differ with, yet at the same time complement, those of previous researchers are reached.

82-1203

On Fracture Behavior of Brittle Cantilever Beam Subjected to Lateral Impact Load

S. Kida and J. Oda
Dept. of Mech. Engrg., Kanazawa Inst. of Tech., 7-1, Ogigaoka, Nonoichimachi, Ishikawa 921, Japan,
Exptl. Mechanics, 22 (2), pp 64-68 (Feb 1982) 4 figs, 4 refs

Key Words: Beams, Impact response, Fracture properties

The fracture patterns produced by concentrated impact loading on brittle beams and their dependence on the impact velocity and beam length has been determined. The experiment was performed using the transverse impact of a steel ball on the free end of cantilever beams made of plaster. The mechanism, location and time sequence of fracture were photographed by a camera connected to a stroboscope or with a high-speed framing camera. It was found experimentally that the concentrated impact loadings produce three characteristic fracture behaviors. Moreover, by using the dynamic photoelastic technique, the authors found it possible to explain theoretically the fracture behavior of this experiment by using the theory of flexural motion of a semi-infinite beam. Hence, applying an impact-fracture criterion to this theory, the fracture patterns of brittle beam can be estimated.

82-1204

Beams under Lateral Projectile Impact

J.G. de Oliveira
Dept. of Ocean Engrg., Massachusetts Inst. of Tech., Cambridge, MA 02139,
ASCE J. Engrg. Mechanics Div., 108 (EM1), pp 51-71 (Feb 1982) 4 figs, 2 tables, 13 refs

Key Words: Beams, Transverse shear deformation effects, Rotatory inertia effects, Boundary condition effects, Impact response

The influence of transverse shear effects, rotary inertia and the boundary conditions on the dynamic behavior of rigid perfectly plastic beams subjected to projectile impact at midspan is studied. Theoretical solutions for a perfectly clamped and a simply supported beam are presented. Numerical results are given for a rectangular and three wide-flanged I-beams of varying spans.

82-1205

Mechanics of Ice-Lifting from a Flat Surface through Penetration with a Sharp Blade

N.C. Huang
Dept. of Aerospace and Mech. Engrg., Univ. of Notre Dame, Notre Dame, IN 46556,
J. Appl. Mechanics, Trans. ASME, 48 (4), pp 936-942 (Dec 1981) 6 figs, 7 refs

Key Words: Ice, Cantilever beams, Timoshenko theory, Impact response, Crack propagation

This paper is concerned with the mechanism of ice-lifting from a flat surface through penetration of the interface by means of a sharp blade. A static case was considered in which the lifted ice was treated as an elastic Timoshenko beam of the cantilever type. The principle of the balance of energy was used in formulating the problem. The objective was to find the relationship between the applied thrust and the length of the crack at the interface. Special attention was focused on the instability phenomenon associated with crack propagation. An experimental program was conducted for comparing the measured critical thrust for instability with the theoretical predictions. The static problem was then generalized to the case of dynamic loading where the sharp blade penetrated the interface through the action of an impact.

CYLINDERS

82-1206

Acoustic Propagation in Finite Length Elastic Cylinders. Part 1: Axisymmetric Excitation

M. El-Raheb
Applied Mechanics, Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA 91109,
J. Acoust. Soc. Amer., 71 (2), pp 296-306 (Feb 1982) 6 figs, 2 tables, 11 refs

Key Words: Cylinders, Sound waves, Wave propagation, Axisymmetric excitation

The acoustic propagation in a perfect finite length thin elastic cylinder is studied from an exact solution to the coupled elasto-acoustic equations of motion. Eigenfunction expansions are obtained for Koiter's consistent shell equations and the Helmholtz equation governing the acoustic field. The acoustic pressure is expressed as the sum of modal acoustic pressures each factored by a normalized influence coefficient related to the corresponding generalized coordinate in the elastic cylinder eigenfunction. A set of nonlinear homogeneous algebraic equations in the generalized coordinates are obtained when satisfying the coupled equations and the compatibility condition at the fluid-cylinder interface. The method when applied to a clamped cylinder filled with water and excited by a plane wave demonstrates the existence of narrow nonresonant peaks in maximum cylinder displacement and a frequency range where the average response rises considerably.

82-1207

Acoustic Propagation in Finite Length Elastic Cylinders. Part II: Asymmetric Excitation

M. El-Raheb

Applied Mechanics, Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA 91109, J. Acoust. Soc. Amer., 71 (2), pp 307-317 (Feb 1982) 9 figs, 1 table, 2 refs

Key Words: Cylinders, Sound waves, Wave propagation, Asymmetric excitation

The propagation of acoustic waves in a perfect finite length elastic cylinder due to an asymmetric excitation is studied. The frequency response of the coupled system involves sharp resonant peaks lagging the rounded peaks at the empty cylinder resonances and nonresonant maxima often caused by modulated coincidence. The maximum acoustic pressure drops off as an empty cylinder resonance is crossed, then recovers gradually with decaying fluctuations as the frequency nears a higher empty cylinder resonance. Although a definite cutoff frequency exists when the boundaries are rigid, the effect is diffused due to the elasticity of the cylinder wall. Nonresonant peaks become more frequent for modes with a circumferential wavenumber that corresponds to the minimum resonance in the empty cylinder spectrum.

MEMBRANES, FILMS, AND WEBS

82-1208

A Review of Approximate Methods for Determining the Vibrational Modes of Membranes

J. Mazumdar

Dept. of Appl. Math., Univ. of Adelaide, Australia, Shock Vib. Dig., 14 (2), pp 11-17 (Feb 1982) 51 refs

Key Words: Membranes (structural members), Mode shapes, Natural frequencies, Approximation methods, Reviews

This paper is a review of the literature dealing with various approximate methods for the study of membrane vibrations that has appeared during the past few years. Two earlier reviews in this series, published in 1975 and 1979, were surveys of world literature on this subject published from the beginning of the 19th century through part of 1977. The present review continues the survey from that period to the present. Recent research dealing with nonlinear effects, forced vibrations, material anisotropy, and other complicating factors is summarized.

PANELS

82-1209

A Quadrilateral Finite Difference Plate Element for Nonlinear Transient Analysis of Panels

C.-M. Ni

Engrg. Mechanics Dept., General Motors Res. Labs., Warren, MI 48090, Computers Struc., 15 (1), pp 1-10 (1982) 10 figs, 13 refs

Key Words: Panels, Transient response, Finite difference technique, Plates, Finite element technique

A quadrilateral plate element for the analysis of nonlinear transient response of panels has been developed based on the variational finite difference method for an irregular mesh. Due to the superior computational characteristics of the variational finite difference method with a lesser degree of continuity constraint on the interpolation functions and the use of lower-order polynomials allowing faster numerical integration methods to be implemented, this plate element is quite competitive or perhaps even superior when compared with the conforming finite elements. Three illustrative problems have been solved using this plate element to demonstrate its capability and accuracy in analyzing the large deformation response of panels subject to dynamic loadings.

PLATES

(Also see Nos. 1140, 1181)

82-1210

High-Amplitude Acoustic Power Losses in Perforated Materials

A. Cummings

Univ. of Missouri-Rolla, Rolla, MO, ASME Paper No. 81-WA/NCA-10

Key Words: Plates, Hole-containing media, Acoustic absorption

This paper presents a theoretical analysis of acoustic absorption at an orifice plate, for high amplitude waves in the absence of mean airflow, and also gives experimental data for comparison. Some consideration is given to the nature of the vortex shedding processes which occur at the orifice plate.

82-1211

Effects of Large Amplitude, Transverse Shear and Rotatory Inertia on Vibration of Orthotropic Elliptical Plates

M. Sathyamoorthy
Dept. of Mech. and Industrial Engrg., Clarkson College of Tech., Potsdam, NY 13676, Intl. J. Nonlin. Mechanics, 16 (3/4), pp 327-335 (1981) 9 figs, 16 refs

Key Words: Plates, Flexural vibration, Transverse shear deformation effects, Rotatory inertia effects

This study is concerned with the large amplitude flexural vibration of orthotropic elliptical plates incorporating the effects of transverse shear and rotatory inertia. With the aid of von Karman-type field equations expressed in terms of the three displacement components approximate solutions to elliptical plates with clamped immovable boundaries are obtained by Galerkin technique and numerical Runge-Kutta procedure. These von Karman-type governing equations which include the effects of transverse shear and rotatory inertia reduce readily to those available in the literature when these effects are neglected. Present results are in good agreement with the existing solutions in the static and dynamic special cases. Numerical results for moderately thick elliptical plates indicate significant influences of the transverse shear deformation and rotatory inertia on the large amplitude vibration behavior.

82-1212

Dynamic Response of Plate on Elastic Half-Space

W.L. Whittaker and P. Christiano
Dept. of Civil Engrg., Carnegie-Mellon Univ., Pittsburg, PA, ASCE J. Engrg. Mechanics Div., 108 (EM1), pp 133-154 (Feb 1982) 14 figs, 36 refs

Key Words: Plates, Elastic half-space, Harmonic analysis

Analytical results are presented for the dynamic response of a plate bearing on an elastic half-space and subjected to harmonic forces. The present work represents a departure from existing analyses in that herein both the flexibility and three-dimensionality of the plate are taken into account. Displacements and contact stresses are presented for square plates having a practical range of flexural stiffness. The harmonic analysis is conducted within the framework of a global stiffness solution, in which the plate and subgrade impedance matrices are formulated independently in accordance with a prescribed discretization pattern. Compatibility of displacements and equilibrium of forces are enforced at the plate-subgrade interface. Solutions are presented for massless square plates subjected to harmonic point, uniform pressure, and moment loadings.

82-1213

Dynamic Buckling of Plates under Longitudinal Impact

J. Ari-Gur, J. Singer, and T. Weller
Dept. of Aeronautical Engrg., Technion-Israel Inst. of Tech., Haifa, Israel, Israel J. Tech., 19 (1-2), pp 57-64 (1981) 8 figs, 1 table, 10 refs

Key Words: Plates, Dynamic buckling, Longitudinal response

Theoretical and experimental studies of buckling of plates subjected to in-plane compression of short durations are presented. Dynamic buckling loads are found to be larger than the static ones. The ratio of these loads increases for thinner plates and for shorter durations of impulse but usually the dynamic amplification for plates is much lower than that for columns. Stiffening of the boundaries, which significantly increases the static buckling load of a plate, appears to be much less efficient for dynamic buckling.

82-1214

Asymmetric Vibrations of a Circular Elastic Plate on an Elastic Half Space

H. Schmidt and S. Krenk
Risø Natl. Lab., DK-4000 Roskilde, Denmark, Intl. J. Solids and Struc., 18 (2), pp 91-105 (1982) 7 figs, 11 refs

Key Words: Plates, Circular plates, Elastic half-space

The asymmetric problem of a vibrating circular elastic plate in frictionless contact with an elastic half space is solved by an integral equation method, where the contact stress appears as the unknown function. By a trigonometric expansion, the problem is reduced to a number of uncoupled two-dimensional problems. The radial variations of contact stresses and surface displacements are represented by polynomials, the coefficients of which are directly related by an infinite matrix that is a function of the vibration frequency. The results include a parametric study of the power input as a function of the vibration frequency of various plate stiffnesses and the normal component of the surface displacement field for simple excitation of the plate and passage of a plane Rayleigh wave.

82-1215

Drive Point Impedance of an Infinite Orthotropic Plate under Tension

I.J. Busch-Vishniac

Acoustics Res. Dept., Bell Labs., Murray Hill, NJ 07974, J. Acoust. Soc. Amer., 71 (2), pp 368-371 (Feb 1982) 4 figs, 8 refs

Key Words: Plates, Orthotropism, Point source excitation, Mechanical impedance

An expression is derived for the drive point impedance of an infinite plate under tension. It is shown that at high frequencies the bending behavior is dominant, and at low frequencies the membrane behavior is dominant. In general an orthotropic plate under tension behaves like a resistance and stiffness combined in parallel.

SHELLS

(Also see No. 1154)

82-1216

Elastic Wave Scattering from Elliptical Shells

M.M. Simon and R.P. Radlinski

Analysis and Tech., Inc., North Stonington, CT 06359, J. Acoust. Soc. Amer., 71 (2), pp 273-281 (Feb 1982) 10 figs, 4 tables, 10 refs

Key Words: Shells, Wave diffraction, Sound waves, Acoustic scattering

The extended boundary condition approach to elastic wave scattering is reformulated for inclusions obeying thin shell theory. Results are presented for the scattering of plane p and sv waves from infinite cylinders of elliptical cross section for ratios of minor to major axis varying from 0.5 to 1.0 (circular). Calculations were made for cylinders of plastic and steel and for elastomers having three different shear moduli.

82-1217

Dynamic Axial Plastic Buckling of Stringer Stiffened Cylindrical Shells

N. Jones and E.A. Papageorgiou

Dept. of Mech. Engrg., The Univ. of Liverpool, P.O. Box 147, Liverpool L69 3BX, UK, Intl. J. Mech. Sci., 24 (1), pp 1-20 (1982) 14 figs, 1 table, 27 refs

Key Words: Shells, Cylindrical shells, Stiffened shells, Dynamic buckling, Perturbation theory

A perturbation method of analysis has been used to examine the dynamic plastic buckling of a stringer-stiffened cylindrical shell subjected to an axial impact. It transpires that it is more efficient to place stiffeners on the outer shell surface rather than on the inner surface. Various results are presented to demonstrate the influence of the second moment of area, eccentricity, cross-sectional area and number of stiffeners on the dynamic plastic response.

82-1218

Buckling of Cylindrical Liquid-Storage Tanks under Earthquake Loading

A. Niwa and R.W. Clough

Univ. of California, Berkeley, CA, Earthquake Engrg. Struc. Dyn., 10 (1), pp 107-122 (Jan-Feb 1982) 13 figs, 1 table, 9 refs

Key Words: Storage tanks, Cylindrical shells, Dynamic buckling, Earthquake damage, Experimental test data

The earthquake response behavior of a cylindrical wine storage tank similar to many that were damaged in Livermore, California during the January 1980 earthquake was studied on the University of California shaking table. Tests induced buckling patterns similar to those observed after the actual earthquake. Observed peak axial compression stresses in the test tank wall were substantially higher than those assumed in typical design standards, demonstrating the need for further study of the buckling problem in tanks free to uplift during earthquake excitation.

82-1219

Numerical Calculation of the Natural Frequencies of a Sloshing Liquid in Axial Symmetrical Tanks under Strong Capillary and Weak Gravity Conditions

U. Schilling and J. Siekmann

Universität Essen, Gesamthochschule, Essen, Fed. Rep. Germany, Israel J. Tech., 19 (1-2), pp 44-50 (1981) 4 figs, 7 refs

Key Words: Natural frequencies, Tanks (containers), Fluid-filled containers, Sloshing

The irrotational motion of a homogeneous, ideal and incompressible liquid which partially fills a tank with rotational symmetry has been investigated under strong capillary and weak gravity conditions. The axis of the container is supposed to be parallel to the direction of the gravitational field. Under the assumptions made the potential flow of the liquid is governed by the Laplace equation, the zero normal velocity condition at the impermeable wall, the condition at the free liquid surface, and the condition for the

contact angle. In order to solve the problem under consideration numerically, the so-called panel method has been applied. Computational experiments show very good agreement with the exact analytical solution for a fluid enclosed in a right circular cylindrical container.

82-1220
Free Vibration Analysis of Cylindrical Liquid Storage Tanks

T. Balendra, K.K. Ang, P. Paramasivam, and S.L. Lee
Dept. of Civil Engrg., Natl. Univ. of Singapore, Singapore, Intl. J. Mech. Sciences, 24 (1), pp 47-59 (1982) 10 figs, 1 table, 17 refs

Key Words: Shells, Cylindrical shells, Storage tanks, Fluid-filled containers, Natural frequencies, Mode shapes, Finite element technique

Cylindrical liquid storage tanks anchored to rigid base slabs are considered. By using finite elements for both liquid and tankwall, the natural frequencies of the coupled system are presented in graphical form for various tank dimensions, liquid depths and wall thicknesses. From the mode shapes it is concluded that during coupled vibration a large core of liquid is practically unaffected.

PIPES AND TUBES
(Also see Nos. 1182, 1319)

82-1221
Dynamic Behavior of Continuous Cantilevered Pipes Conveying Fluid Near Critical Velocities

J. Rousselet and G. Herrmann
Ecole Polytechnique de Montreal, Montreal, Quebec H3C 3A7, Canada, J. Appl. Mechanics, Trans. ASME, 48 (4), pp 943-947 (Dec 1981) 5 figs, 8 refs

Key Words: Pipes (tubes), Cantilever beams, Fluid-induced excitation, Flutter

The plane motion of a cantilevered pipe conveying fluid is examined when the flow velocity is in the neighborhood of that generating flutter. In contrast to previous studies, the flow velocity is not prescribed as a constant, but is determined from the laws of motion. We are thus led to a system of two nonlinear partial differential equations which are coupled through the nonlinear terms. The solution is found by the use of the Krylov-Bogoliubov averaging method and the results are discussed indicating the effect of nonlinearities.

82-1222
Seismic Analysis of Piping System Subjected to Multiple Support Excitations

C. Sundararajan, A.K. Valsh, and G.C. Slagis
EDS Nuclear, Inc., San Francisco, CA, ASME Paper No. 81-WA/PVP-2

Key Words: Piping systems, Nuclear reactor components, Seismic excitation, Supports

Results are presented of a comparative study between the multiple response spectrum method and the time-history method for the seismic analysis of nuclear piping systems subjected to different excitation at different supports or support groups. Necessary equations for the above analysis procedures are derived. Three actual nuclear piping systems subjected to single and multiple excitations are analyzed by the different methods, and extensive comparisons of the results (stresses) are made. Based on the results, it is concluded that the multiple response spectrum analysis gives acceptable results as compared to the "exact," but much more costly, time-history analysis.

82-1223
Probability of Pipe Fracture in the Primary Coolant Loop of a PWR Plant. Volume 2: Primary Coolant Loop Model

A.C. Eberhardt
Lawrence Livermore Natl. Lab., CA, Rept. No. UCID-18967-VOL-2, 150 pp (Sept 1981)
NUREG/CR-2189-V2

Key Words: Pipes (tubes), Fracture properties, Nuclear power plants, Nuclear reactor components, Seismic response

This report describes the Zion Station reactor coolant loop model developed for Lawrence Livermore National Laboratory as part of its Load Combination Program. This model was developed for use in performing seismic time history analyses of an actual pressurized water reactor system. It includes all major items affecting the seismic response of a 4-loop Westinghouse nuclear steam supply system: the components, supports, and interconnecting piping. The model was further expanded to permit static analysis of dead weight, thermal, and internal pressure load conditions.

82-1224
Probability of Pipe Fracture in the Primary Coolant Loop of a PWR Plant. Volume 3: Nonseismic Stress Analysis

A.L. Chan, D.J. Curtis, E.F. Rybicki, and S.C. Lu

Lawrence Livermore Natl. Lab., CA, Rept. No. UCID-18967-VOL-3, 75 pp (Aug 1981)
NUREG/CR-2189-V3

Key Words: Pipes (tubes), Fracture properties, Nuclear power plants, Nuclear reactor components

This volume describes the analyses used to evaluate stresses due to loads other than seismic excitations in the primary coolant loop piping of a selected four-loop pressurized water reactor nuclear power station. The results of the analyses are used as input to a simulation procedure for predicting the probability of pipe fracture in the primary coolant system. Sources of stresses considered in the analyses are pressure, dead weight, thermal expansion, thermal gradients through the pipe wall, residual welding, and mechanical vibrations.

82-1225

Probability of Pipe Fracture in the Primary Coolant Loop of a PWR Plant. Volume 4: Seismic Response Analysis

S.C. Lu, S.M. Ma, and R.A. Larder
Lawrence Livermore Natl. Lab., CA, Rept. No. UCID-18967-VOL-4, 75 pp (Sept 1981)
NUREG/CR-2189-V4

Key Words: Pipes (tubes), Fracture properties, Nuclear power plants, Nuclear reactor components, Seismic response

This volume of the report gives a detailed account of the seismic response analysis of the primary coolant loop piping of Unit 1 of the Zion Nuclear Power Station. Because the purpose of this work was to perform a realistic simulation, best estimate loads and material properties were used for the calculation whenever possible. When such data were unavailable, conservative values were used. The calculation procedure included the generation of seismic input, the determination of dynamic soil properties, a three-part soil-structure-piping interaction analysis, and the post-response data procession. A large number of variables considered in the analysis can affect the seismic response stresses. This volume describes a sensitivity study as well as the method of analysis. The sensitivity study is included to establish confidence in the computed response stresses.

82-1226

Probability of Pipe Fracture in the Primary Coolant Loop of a PWR Plant. Volume 5: Probabilistic Fracture Mechanics Analysis

D.O. Harris, E.Y. Lim, and D.D. Dedhia
Lawrence Livermore Natl. Lab., CA, Rept. No. UCID-18967-VOL-5, 374 pp (Aug 1981)
NUREG/CR-2189-V5

Key Words: Pipes (tubes), Fracture properties, Nuclear power plants, Nuclear reactor components

The purpose of the portion of the Load Combination Program covered in this volume was to estimate the probability of a seismic induced loss-of-coolant accident in the primary piping of a commercial pressurized water reactor. Such results are useful in rationally assessing the need to design reactor primary piping systems for the simultaneous occurrence of these two potentially high stress events. The primary piping system at Zion I was selected for analysis. Attention was focused on the girth butt welds in the hot leg, cold leg and cross-over leg, which are centrifugally cast austenitic stainless steel lines with nominal outside diameters of 32-37 inches.

82-1227

Probability of Pipe Fracture in the Primary Coolant Loop of a PWR Plant. Volume 6: Failure Mode Analysis

R.D. Streit
Lawrence Livermore Natl. Lab., CA, Rept. No. UCID-18967-VOL-6, 58 pp (Sept 1981)
NUREG/CR-2189-V6

Key Words: Pipes (tubes), Fracture properties, Nuclear power plants, Nuclear reactor components, Failure analysis

Material properties and failure criteria were evaluated to assess the requirements for double-ended guillotine break in the primary coolant loop of the Zion Unit 1 pressurized water reactor. The properties of the 316 stainless steel piping materials were obtained from the literature. Statistical distributions of both the tensile and fracture properties at room and operating temperatures were developed. Yield and ultimate strength tensile properties were combined to estimate the material flow strength. The flow strength and fracture properties were used in the various failure models analyzed. Linear-elastic, elastic-plastic, and fully plastic fracture models were compared, and the governing fracture criterion was determined. For the particular case studied, the fully plastic flow requirement was found to be the controlling fracture criterion leading to a double-ended guillotine pipe break.

DUCTS

(Also see No. 1312)

82-1228

Propagation of Long Waves in Acoustically Treated, Curved Ducts

W. Rostafinski

NASA Lewis Res. Ctr., Cleveland, OH 44135, J. Acoust. Soc. Amer., 71 (1), pp 36-41 (Jan 1982) 8 figs, 2 tables, 8 refs

Key Words: Ducts, Curved ducts, Acoustic linings, Sound propagation

A two-dimensional, detailed study is presented on the behavior of long waves in lined, curved ducts. The analysis includes a comparison between the propagation in curved and straight lined ducts. A parametric study was conducted over a range of wall admittance and duct wall separation. The complex eigenvalues of the characteristic equation, which in the case of a curved duct are also the angular wavenumbers, have been obtained by successive approximations. Galerkin's method. Unlike finite element approaches, this analysis includes the effects of realistic sources and the number of peripheral strips need not be small. It is shown that peripherally segmented liners redistribute the acoustic energy in waves composed of only a single circumferential mode at the source into other waves which contain a multitude of circumferential modes in the lined section. The accuracy of eigenfunctions computed from the analysis was observed to increase as either the frequency or radial mode order increased. The transmission losses were found to be accurate at frequencies above the cut-on value of the first-order radial mode in a hard-wall duct. The results show that for plane wave sources, peripherally segmented liners may attenuate as much sound as an optimized uniform liner at the optimal point while giving more noise suppression at most other frequencies.

82-1229

High Order Mode Acoustic Transmission through the Walls of Rectangular Ducts

A. Cummings

Univ. of Missouri-Rolla, Rolla, MO, ASME Paper No. 81-WA/NCA-11

Key Words: Ducts, Sound transmission

As an extension of previous work on low frequency fundamental mode transmission through the walls of rectangular ducts, results are presented on the transmission of internally propagated higher order acoustic modes through duct walls. Subject to various assumptions, it is possible to obtain analytical solutions to the structural wave equation governing the motion of the duct's walls, and this is used to predict the response of the walls to the internal acoustic pressure field.

82-1230

Noise Suppression Characteristics of Peripherally Segmented Duct Liners

W.R. Watson

NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TP-1904, L-14521, 43 pp (Sept 1981) N81-33946

Key Words: Ducts, Acoustic linings, Noise reduction

The acoustic fields and transmission losses produced in semi-infinite circular ducts with peripherally segmented liners are analyzed using a series expansion of hard-wall duct modes. The coefficients of the series are computed using

82-1231

Influence of Exit Impedance on Finite Difference Solutions of Transient Acoustic Mode Propagation in Ducts

K.J. Baumeister

NASA Lewis Res. Ctr., Cleveland, OH 44135, J. Engrg. Indus., Trans. ASME, 104 (1), pp 113-120 (Feb 1982) 11 figs, 24 refs

Key Words: Ducts, Acoustic impedance, Sound propagation

The numerical analysis is described which models the closed-form pressure solutions for cutoff and propagating acoustic modes in a semi-infinite duct. The first section of the paper presents the various equations and boundary conditions governing sound propagation in a duct without a mean flow. The second section then presents the difference form of the governing equations. Analytical approximations (steepest descent) are presented as a guide to the understanding of the numerical results that follow. Numerical calculations are presented at forcing frequencies above, below, and nearly at the cutoff frequency. An explanation is presented for the computational instability associated with cutoff modes. Recommendations are made on how to handle cutoff mode propagation.

BUILDING COMPONENTS

82-1232

Seismic Behavior of Moment Connections and Joints

H. Krawinkler and E.P. Popov

Stanford Univ., Stanford, CA, ASCE J. Struc. Div., 108 (ST2), pp 373-381 (Feb 1982) 15 figs, 19 refs

Key Words: Joints (junctions), Beam-colums, Structural members, Seismic response, Fatigue life

The behavior of moment connections and beam-column joints in moment resisting steel frames subjected to severe earthquakes is studied. The cyclic inelastic deformation capacities of different types of connections are discussed and design recommendations are presented that are intended to assure the development of plastic hinges in beams at the column faces. A conceptual approach to the prediction of the low cycle fatigue life of welded connections under random loading is outlined, utilizing concepts of elastic-plastic fracture mechanics. The shear behavior of beam-column joints subjected to large cyclic beam moment reversals is summarized. Based on experimental evidence and a simplified mathematical model for shear strength, a method for the shear design of joints is proposed that should permit a reduction in the demand for shear stiffeners in joints.

82-1233

Generation of Lateral and Rotational Floor Response Spectra by an Alternative Approach

H.F. Ishac and A.C. Heiderbrecht

Civil Design Dept., Ontario Hydro, 700 University Ave., Toronto, Canada, Earthquake Engrg. Struc. Dynam., 10 (1), pp 47-58 (Jan-Feb 1982) 6 figs, 3 tables, 14 refs

Key Words: Floors, Nuclear reactors, Seismic response, Response spectra

A procedure is described to compute the lateral and rotational floor response spectra of an asymmetric reactor building structure without a time history analysis. The spectral values obtained by filtering the prescribed ground motion first through the structure and the resulting lateral-rotational motions through simple oscillators are equal to the maximum lateral-rotational responses of the structure developed when the order of filtration is reversed. Based on the preceding concept a deterministic method is presented to construct the lateral-rotational floor response spectra utilizing the response spectrum technique.

82-1234

Sound Transmission Loss of Gypsum Wallboard Partitions. Report No. 1. Unfilled Steel Stud Partitions

D.W. Green and C.W. Sherry

Domtar Inc., Research Ctr., Senneville, Quebec, Canada H9X 3L7, J. Acoust. Soc. Amer., 71 (1), pp 90-96 (Jan 1982) 8 figs, 5 tables, 7 refs

Key Words: Walls, Sound transmission loss

Statistical equations based on surface density are derived for predicting the sound transmission loss and sound transmission class of double leaf wall partitions. The partitions are composed of gypsum wallboard attached to light gauge steel studs with screws. The equations, which accurately predict the STL and STC, are in good agreement with results obtained at other laboratories but not with theoretical predictions reported in the literature. Using the equations to investigate the effect of variations in wall constructions on acoustic performance, it was found that the primary factors that affect sound transmission loss are surface density, stud size, method of attaching the panels to the studs, and the method of laminating the sheets in multilayer construction. No improvement in STC was noted for partitions having balanced construction.

ELECTRIC COMPONENTS

MOTORS

(Also see No. 1193)

82-1235

Evaluation of the SCR Controller Noise Problem

R.B. Bassett and B.E. Barnaby

Sandia Natl. Labs., Albuquerque, NM, Rept. No. SAND-81-1814C, CONF-811010-2, 8 pp (1981) DE81026462

Key Words: Electric vehicles, Motors, Noise generation

Several types of solid state controllers are available for application to electric vehicles. The silicon controlled rectifier (SCR) type provides a current waveform of fixed pulse height and variable ratio on to off time. The controller provides step-free operation through a four-speed manual transmission. However, because the current is chopped, the circuits produce loud hums of varying frequency, which in some mounting situations may be amplified. This noise disappoints those who expect an electric vehicle to boast relatively silent operation. To evaluate the problem, components of a test bed, consisting of a battery bank, dc motor, SCR controller, charger, and appropriate cabling, were fitted with accelerometers, and the noises were evaluated for amplitude and spectral characteristics. Transient currents and voltages were also measured and analyzed to identify the source of the noise and the frequencies involved.

TRANSFORMERS

82-1236
Power Transformer Noise -- Generation, Propagation and Control -- A Review
P. Saha
Blachford Engineers, Troy, MI, ASME Paper No. 81-WA/NCA-3

Key Words: Transformers, Electric components, Noise generation, Sound propagation, Noise reduction

Available literature regarding the generation, propagation and control of power transformer acoustic noise is reviewed. Emphasis is given on understanding the propagation of the noise from the transformer site to the surrounding areas for effective noise control purposes.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION
(Also see Nos. 1307, 1328)

82-1237
Approximate Fluid-Structure Interaction Theories for Acoustic Echo Signal Predictions
H. Huang
Naval Res. Lab., Washington, DC, Rept. No. NRL-MR-4661, 17 pp (Oct 19, 1981)
AD-A106 349

Key Words: Interaction: structure-fluid, Submerged structures, Sound reflection

An approximate scheme for predicting the acoustical echo signals from submerged elastic structures irradiated by incident pulses is proposed and investigated for its effectiveness. This scheme utilizes various approximate fluid-structure interaction theories to first determine the resultant pressure and normal acceleration on the fluid-structure interface and therefrom calculates the far field echo signals by integrating the Helmholtz integral exactly.

82-1238
Estimation of the Mean Velocity of Acoustic Signal Propagation for Sea Operations
H.C. Menck
Western Electric Co., Inc., Greensboro, NC, ASME Paper No. 81-WA/OCE-10

Key Words: Elastic waves

This paper discusses the mathematical foundations, computation equations and operational guidelines associated with a software algorithm that has been developed to enable shipboard computer processing of on-site velocity profile data to produce mean velocity estimates. The paper specifically addresses the problem of generating accurate curvilinear raypath data at sea with a shipboard computer system in order to express, in real-time, the mean velocity of acoustic propagation as a functional of measured travel times and known receiver depths within localized sea operations areas.

82-1239
Generalized Kirchhoff Approach to the Ocean Surface-Scatter Communication Channel. Part 1. Transfer Function of the Ocean Surface
L.J. Ziomek
Ocean Tech. Dept., Appl. Res. Lab., Pennsylvania State Univ., P.O. Box 30, State College, PA 16801, J. Acoust. Soc. Amer., 71 (1), pp 116-126 (Jan 1982)
2 figs, 1 table, 22 refs

Key Words: Underwater sound

The underwater acoustic propagation path between transmit and receiver planar arrays via the surface of the ocean is treated as a linear, time-varying, random WSSUS communication channel. The random, time-varying, transfer function of the ocean's surface is derived for a bistatic geometry using a generalized Kirchhoff approach. The result for the bistatic configuration can then be easily reduced to either the specular or backscatter geometries. The generalized Kirchhoff approach uses a Fresnel corrected Kirchhoff integral, no small slope approximation, and the Rayleigh hypothesis that the scattered acoustic pressure field can be represented as a superposition of plane waves traveling in many different directions.

82-1240
A Scattering Function Approach to Underwater Acoustic Detection and Signal Design
L.J. Ziomek
Appl. Res. Lab., Pennsylvania State Univ., State College, PA, Rept. No. ARL/PSU/TM-81-144, 300 pp (Oct 7, 1981)
AD-A105 593

Key Words: Underwater sound, Acoustic detection, Acoustic scattering

In this dissertation, the design of transmit and processing waveforms is used to maximize the signal-to-interference ratio to improve the detectability of a doubly spread target return in the presence of volume and/or surface reverberation plus white Gaussian noise. The ratio is dependent upon target and reverberation scattering functions and the cross-ambiguity function of the transmit and processing waveforms. Volume reverberation, target, and surface reverberation scattering functions are derived. Volume reverberation is modeled as the spatially uncorrelated scattered field from randomly distributed point scatterers in deterministic plus random translational motion.

82-1241

Interior and Exterior Resonances in Acoustic Scattering. I - Spherical Targets, II - Targets of Arbitrary Shape (T-Matrix Approach)

G.C. Gaunaurd, E. Tanglis, H. Ueberall, and D. Brill
Dept. of Physics, Catholic Univ. of America, Washington, DC, Interim Rept. Feb 1 - Sept 30, 1981, 65 pp (Sept 14, 1981)
AD-A105 534

Key Words: Acoustic scattering

Spherical Targets. In acoustic scattering from elastic objects, resonances features appear in the returned echo at frequencies where the objects eigenfrequencies are located, which are explained by the excitation of interior creeping waves. Corresponding resonance terms may be split off from the total scattering amplitude, leaving behind an apparently nonresonant background amplitude. This is demonstrated here for scatterers of spherical geometry, and in the following companion paper also for scatterers or arbitrary geometry, using the T-matrix approach. For the case of near-impenetrable spheres, it is subsequently shown that the background amplitude can be split further into specularly reflected contributions, plus highly attenuated resonance terms which are explained by the excitation of exterior (Franz-type) creeping waves.

82-1242

Scattering of Transient Elastic Waves by an Inhomogeneous Obstacle: Contrast in Volume Density of Mass

G.C. Herman
Dept. of Electrical Engrg., Lab. of Electromagnetic Res., Delft Univ. of Tech., P.O. Box 5031, 2600 GA Delft, The Netherlands, J. Acoust. Soc. Amer., 71 (2), pp 264-372 (Feb 1982) 7 figs, 1 table, 10 refs

Key Words: Elastic waves, Wave diffraction

A method is described to compute the scattering of transient elastic waves by arbitrarily shaped, three-dimensional, inhomogeneous, penetrable objects of bounded extent that only differ from their surroundings in their volume density of mass. The problem is formulated in terms of a volume-integral equation over the interior of the scatterer. This integral equation is solved numerically by the marching-on-in-time method. Another numerical method to solve the integral equation by iteration is discussed. Comparison is made with analytical results for a spherical, homogeneous scatterer, while some numerical results for scatterers of different shapes are presented.

82-1243

Paper Noise in an Impact Line Printer

I.J. Busch-Vishniac and R.H. Lyon
Bell Labs., Murray Hill, NJ 07974, J. Acoust. Soc. Amer., 70 (6), pp 1679-1689 (Dec 1981) 9 figs, 1 table, 15 refs

Key Words: Paper products, Noise generation, Printing, Noise reduction

It is shown that in typical impact line printers both nonresonant and resonant paper vibration are significant mechanisms of sound generation. Both can probably be controlled by increasing the backing bar stiffness of the printer while keeping the printing force constant. The paper-hammer impact on the backing bar dominates paper impact noise below 1250 Hz. Above 2500 Hz the hammer impact on the paper is the dominant source. From 1250-2500 Hz the two impacts contribute equally to the sound generation. Consideration of the design of a quiet paper leads to the suggestion of a paper with high density and low bending rigidity. This might be accomplished through microcreping of the paper.

82-1244

Method for Computing the Sound Power of Machines Based on the Helmholtz Integral

G.H. Koopmann and H. Benner
Mech. Engrg. Dept., Univ. of Houston, Houston, TX 77004, J. Acoust. Soc. Amer., 71 (1), pp 78-89 (Jan 1982) 11 figs, 11 refs

Key Words: Machinery noise, Sound power levels, Design techniques, Helmholtz integral method

A computational method is presented for assessing the sound power characteristics of machines. The method, which is based upon a Helmholtz integral formulation, requires a knowledge of the geometry and the modal characteristics of a machine's vibrating surfaces so that the pressure on the surface can be computed. Closed form integration of the associated surface integrals is carried out in a piecewise manner over planar surface elements in the shape of rectangles or triangles. This choice of element allows the grid geometries associated with the acoustic power computations to be made identical to those used in existing structural modal analysis methods. In this way the sound power characteristics of a given machine can be computed in terms of the sound power radiated by each of the structural modes comprising the overall response. The structural modes can then be ranked in order of their radiation efficiency for purposes of noise control treatments. The accuracy of the method is demonstrated by calculating the pressure on the surface of a uniformly pulsating sphere and of an oscillating sphere for values of ka (dimensionless frequency) up to 10.

82-1245

Sound Power Prediction Using the Helmholtz-Kirchhoff Integral Equation

H. Benner and G.H. Koopmann

Univ. of Houston, Houston, TX, ASME Paper No. 81-WA/NCA-4

Key Words: Sound power levels, Noise prediction, Helmholtz integral method, Machinery noise

This paper describes a technique for computing the sound power radiated by machines. Coordinates describing the surface of the machine, together with the velocity distribution of the surface, are inputs to a computer program based on the Helmholtz-Kirchhoff integral equation.

SHOCK EXCITATION

(Also see Nos. 1294, 1310, 1311, 1325)

82-1246

Shock Front Rise Time in Water

P. Harris and H.-N. Presles

Large Caliber Weapon Systems Lab., Army Armament Res. and Dev. Command, Dover, NJ, Rept. No. ARLCD-TR-81032, AD-E400 719, 30 pp (Oct 1981) AD-A105 704

Key Words: Water, Shock wave propagation

A review is made of the present status of the experimental-theoretical program for the evaluation of the shock front thickness in water, and the results of recently performed hyperbolic tangent shock front structure calculations are presented. The hyperbolic tangent results, when compared with experimental data, predict a shock front thickness upper limit of 6.2 x 10 to the minus 6th power cm at 5.8 kbar. Experiments and theory planned for the near future are outlined. These experiments will involve shock front optical reflectivity and shock polarization voltage measurements.

82-1247

Calculation of the Response of an Impulsively Excited Oscillator in an Infinite Acoustic Fluid

A.V. Clark, Jr. and A.M. Whitman

Dept. of Mech. Engrg. and Appl. Mechanics, Univ. of Pennsylvania, Philadelphia, PA 19104, J. Appl. Mechanics, Trans. ASME, 48 (4), pp 749-752 (Dec 1981) 13 refs

Key Words: Interaction: structure-fluid, Submerged structures, Oscillators, Impact response

The response of an impulsively excited single-degree-of-freedom oscillator submerged in an infinite acoustic fluid is considered. The character of the response is determined by the quantity ka; k is the wave number associates with the in-vacuo natural frequency of the oscillator, and a is a characteristic structural dimension. For low-frequency oscillators ($ka \ll 1$), the response consists of two parts. The first is the usual hydrodynamic solution in which the effect of the fluid on the structure is that of an added mass. The second is much smaller (of order ka) and is significant only in a "boundary layer" in time of order a/c, with c the fluid sonic velocity. For high-frequency oscillators ($ka \gg 1$), the principal effect of the fluid is a decay of oscillator vibration due to sound radiation.

82-1248

Uncoupling Approximations in Fluid-Structure Interaction Problems with Cavitation

F.L. DiMaggio, I.S. Sandler, and D. Rubin

Dept. of Civil Engrg. and Engrg. Mechanics, Columbia Univ., New York, NY 10027, J. Appl. Mechanics, Trans. ASME, 48 (4), pp 753-756 (Dec 1981) 8 figs, 3 refs

Key Words: Interaction: structure-fluid, Underwater structures, Shock wave propagation, Cavitation

A linear and a nonlinear interactive scheme have been developed to uncouple the equations of motion of a structure from those of a cavitating fluid in which it is immersed, and through which a shock wave propagates and impinges on the structure. The method has been tested numerically on one-dimensional problems for which the exact solution is obtainable. In these cases, the nonlinear interactive approximation gives especially good results, even when the cavitation phase on the wet surface of the structure is of a long duration.

82-1249

Large Amplitude Compression and Shear Wave Propagation in Impact-Loaded PMMA

Y.M. Gupta
SRI International, Menlo Park, CA, Rept. No. ARO-15513.2-E, 7 pp (Oct 1981)
AD-A105 953

Key Words: Wave propagation, Compression waves, Shear waves, Shock waves

The goal of this research was to develop an improved understanding of the high strain rate material response of polymers by studying the propagation of large-amplitude, one-dimensional compression and shear waves in impact-loaded polymethyl methacrylate. Experimental techniques were designed and developed to permit measurement of large-amplitude shear waves. Measurements were made of the shear particle velocity at the impact surface and in the sample interior. The measurement of sheer wave velocities permitted the first determination of the shear and bulk modulus in the shocked state. The shear wave profiles measured at several gage locations in the sample were integrated (using a Lagrangian analysis for compression and shear waves) to provide shear stress-strain response in the shocked state. These results are the first of their kind and provide an important constraint on the shear (or deviator) response of the material.

82-1250

Impact Force Prediction Using Measured Frequency Response Functions

R.J. Thornhill and C.C. Smith
International Business Machines Corp., Austin, TX, ASME Paper No. 81-WA/DSC-17

Key Words: Impact load prediction, Frequency response function

A method is presented for predicting impact forces using measured frequency response functions when an ideal mass elastically impacts a stationary structure. It is shown that a frequency response function measured at the point of impact on the structure together with the impactor's mass and velocity can be used to form a function which, after inverse Fourier transformation, yields the predicted force.

82-1251

Deformation, Speed and Acceleration of Plastic Systems Exposed to Shock Wave Loads in the Air Deformation (Hastighet och Acceleration Foer Plastiska System Utsatta Foer Luftstoetvaagsbelastning)

J.E. Jonasson
Foersvarets Forskningsanstalt, Stockholm, Sweden, Rept. No. FOA-C-20373-D4 (A3), 48 pp (Oct 1980)
N82-10446
(In Swedish)

Key Words: Shock waves, Plastic deformation, Computer programs

Complete analytical expressions are presented for a system with one degree of freedom whose inner resistance is assumed to be constant during the distortion. A base for a dynamic calculation of the first distortion process, with the aid of a minicomputer is given. Arbitrarily chosen load data can be translated into a simplified load-time-scheme which includes the case of a pure impulse load and long lasting pressure effects. A calculation of the maxima deformation for different load functions, in size and time is reported for the case of the plate simply fastened along two opposite sides, and for the case of a plate fastened along the four sides. In this analysis, the real system is translated to an equivalent one degree of freedom system.

82-1252

An Engineering Prediction Model of Acceleration Response Spectra and Its Application to Seismic Hazard Mapping

T. Katayama
Inst. of Industrial Science, Univ. of Tokyo, 7-22-1 Roppongi, Minato-ku, Tokyo, Japan, Earthquake Engrg. Struc. Dyn., 10 (1), pp 149-163 (Jan-Feb 1982) 14 figs, 4 tables, 8 refs

Key Words: Seismic response, Damage prediction

A regression analysis was made on 277 acceleration response spectra computed from Japanese accelerograms by sub-

dividing the data into discrete categories. Five magnitude and distance categories, and four ground condition categories were used. The maximum absolute acceleration amplitude is predicted as a product of three factors, each representing a weighting factor for magnitude, distance and ground condition category at each of the 18 response spectrum periods. A method was then developed to evaluate seismic hazard in terms of acceleration response spectrum by using the prediction model and the seismicity data, and it was applied to obtain seismic macro-zoning maps of Japan which are dependent on the natural period of a structure. The results of the analysis indicated that a single seismic zoning map may not be sufficient to cover a variety of structures with a wide range of periods because the expected spectral shape differs according to the seismicity of the area.

82-1253

Evaluations of Five Nuclear Weapons Effects Programs Developed by Horizons Technology, Inc.

M.L. Potochi

School of Engrg., Air Force Inst. of Tech., Wright-Patterson AFB, OH, Rept. No. AFIT/GNE/PH/81M-8, 123 pp (Mar 1981)
AD-A106 388

Key Words: Nuclear weapons effects, Computer programs

Five programs are presented and evaluated in ths report. These programs are: Overpressure - Near Ideal Surface; Cratering - Radius and Depth II; Overpressure Phenomena; Nuclear Blast Overpressure; and Dynamic Pressure Phenomena. The evaluations are made by comparisons to standard references. A brief description of the phenomena and a listing of the program equations are included.

VIBRATION EXCITATION

(Also see No. 1278)

82-1254

Pendulum Analogy for Nonlinear Fluid Oscillations in Spherical Containers

B.A. Sayar and J.R. Baumgarten

Mech. Engrg. Dept., Stevens Inst. of Tech., Castle Point Station, Hoboken, NJ 07030, J. Appl. Mechanics, Trans. ASME, 48 (4), pp 769-772 (Dec 1981) 7 figs, 9 refs

Key Words: Spherical shells, Fluid mass, Pendulums, Vibration response

The nonlinear response of a pendulum model is compared to that of fluid motion in a spherical container undergoing lateral oscillations. It is observed that the pendulum does not duplicate the nonlinear response of the fluid except at a particular fluid height. The strong boundary curvature of the spherical container is blamed for this disagreement. Therefore, a cubic spring is included to provide sufficient elasticity to compensate for the boundary effects. The proper values for the coefficient of the cubic spring are found from an experimental observation of planar fluid motion in a spherical tank. It is also noted that, if the pendulum and the fluid are not constrained to a planar motion, at a certain excitation amplitude and frequency, both depart from the plane of excitation and rotate about a vertical axis. The upper and lower boundaries of this rotational motion of the fluid are obtained by a mathematical analysis of its analog pendulum model and compared to those measured experimentally. Mathematical predictions agreed more favorably with the experimental results after the inclusion of the cubic spring in the pendulum model.

82-1255

Frequency Response Analysis of Ocean Wave Energy Converter

M. Masubuchi and R. Kawatani

Osaka Univ., Japan, ASME Paper No. 81-WA/DSC-10

Key Words: Frequency response, Water waves, Energy conversion

Theoretical analysis is presented for the dynamic behavior and energy conversion efficiency of a wave energy converter which is oscillating and absorbing power in an incident sinusoidal wave train.

82-1256

On the Manipulation of Spreading Rates of Forced Mixing Layers

C.-M. Ho and Y.-Q. Zhang

Dept. of Aerospace Engrg., Univ. of Southern California, Los Angeles, CA, 5 pp (Sept 1981)
AD-A105 236

Key Words: Fluid-induced excitation

The vortex merging in a mixing layer can be modified by applying periodic forcing at the origin. When the forcing parameters (frequency, amplitude as well as phase difference between fundamental and subharmonic) varies, the pattern of vortex merging changes. Consequently, the spreading rate

of the mixing layer can be manipulated. The effect of each forcing parameter on the change in the spreading is discussed.

82-1257

Experimental Investigation of Pressure Oscillations in a Side Dump Ramjet Combustor

W.H. Clark

Naval Weapons Ctr., China Lake, CA, J. Spacecraft, 19 (1), pp 47-53 (Jan-Feb 1982) 15 figs, 3 tables, 4 refs

Key Words: NASTRAN (computer program), Combustion engines, Combustion excitation

A two-inlet, side dump ramjet combustor configuration was tested in a connected-pipe setup using uncooled and uninsulated chamber walls. High amplitude combustion induced pressure oscillations were observed during most test conditions with a predominant frequency of around 300 Hz. Special efforts were made to relate the oscillations to longitudinal acoustic modes. A simplified no flow, uniform temperature acoustic cavity prediction method (NASTRAN) was utilized to model the longitudinal acoustic modes. This model was verified via room temperature laboratory tests using the actual test hardware and a loudspeaker as an input forcing function to excite the acoustic modes. During combustion tests, the measured oscillation modes were tenatively identified as second or third longitudinal modes or a "bulk" mode, depending on the test conditions.

MECHANICAL PROPERTIES

DAMPING

82-1258

Dynamic Profile of a Prototype Pivoted Proof-Mass Actuator

D.W. Miller

Space Systems Lab., Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. NASA-CR-164861, SSL-29-81, 29 pp (Aug 1981)

N81-33450

Key Words: Dampers

A prototype of a linear inertial reaction actuation (damper) device employing a flexure-pivoted reaction (proof) mass is discussed. The mass is driven by an electromechanic motor using a dc electromagnetic field and an ac electromagnetic drive. During the damping process, the actuator dissipates structural kinetic energy as heat through electromagnetic damping. A model of the inertial, stiffness and damping properties is presented along with the characteristic differential equations describing the coupled response of the actuator and structure. The equations, employing the dynamic coefficients, are oriented in the form of a feedback control network in which distributed sensors are used to dictate actuator response leading to a specified amount of structural excitation or damping.

82-1259

High Speed Rolling Friction on Viscoelastic Substrates: The Determination of the Hysteretic Damping Factor

V.G. Zankin and W.O. Yandell

School of Civil Engrg., Univ. of New South Wales, Kensington, New South Wales 2033, Australia, Wear, 72 (2), pp 157-185 (Oct 15, 1981) 13 figs, 12 tables, 2 refs

Key Words: Rolling friction, Hysteretic damping

High speed rolling friction phenomena on rubber substrate materials were investigated under various loads and temperatures. Tests were conducted on two tire tread rubber substrates (filled tread rubber and unfilled tread rubber equivalent) using rolling cylinders under approximately plane stress conditions. Rolling friction measurements were converted to a corresponding damping factor -- a quantitative measure of the energy loss. High speed hydrodynamic pressure drag effects on the unfilled rubber substrate are considered, in addition to the viscoelastic contribution, to be responsible for hysteresis losses. The filled rubber substrate showed a departure from viscoelastic hysteresis behavior; this is attibuted to the temporary breakdown of filler particle agglomerates at elevated temperatures. The characteristic frequency of deformation at a single rolling speed and cylinder size is considered to be independent of the length of contact.

82-1260

Analysis and Design of Segmented Dampers for Rotor Dynamic Control

D.L. Taylor and V.S. Fehr

Sibley School of Mech. and Aerospace Engrg., Cornell Univ., Ithaca, NY 14853, J. Lubric. Tech., Trans. ASME, 104 (1), pp 84-90 (Jan 1982) 10 figs, 2 tables, 8 refs

Key Words: Dampers, Segmented film dampers, Shafts, Rotating machinery

Dampers have become of increasing importance in the control of shaft vibration of rotating equipment which must operate through one or more critical speeds. This paper presents the analytical results for the study of a new class of damper, the segmented film damper. A series of isolated segments of fluid are used rather than a continuous film as in the traditional squeeze film damper. This configuration provides energy dissipation through fluid viscosity within the film segments and through oriface flow in the supply and exit ports for each segment. The pressure distribution within an individual segment is developed on the basis of Reynolds equation with appropriate boundary conditions. The effects of various parameters are discussed in terms of this pressure distribution. The geometric effects of multiple segments are derived for both input (how shaft motion excites each segment) and output (how the segments' pressure distributions combine to provide a net force).

82-1261
Mechanical Damping of Filled Plastics

L.E. Nielsen
3208 N.W. Lynch Way, Redmond, OR 97756, Shock Vib. Dig., 14 (1), pp 15-16 (Jan 1982) 14 refs

Key Words: Material damping, Plastics, Reviews

Recent important results on the damping of filled plastics are reviewed. The nature of the plastics-filler interface is especially important in determining the damping of a filled system. Short-fiber composites have damping behavior very different from that of continuous fiber composites. Particle size, particle packing, and particle agglomeration also are important.

FATIGUE

82-1262
Planning, Performance and Evaluating Fatigue Life Tests of Traction Drives with Elastic Lining (Planung, Durchführung und Auswertung von Lebensdaueruntersuchungen an Walzgetrieberädern mit weichelastischem Belag)

G.W. Sackmann
Fortschritt-Berichte VDI-Zt., Reihe 1 (83), 56 pp (1981) 36 figs, 1 table. Summarized in VDI-Z., 123 (19), pp 813-814 (Oct 1981). Avail: VDI-Verlag GmbH, Postfach 1139, 4000 Dusseldorf 1, Germany. Price: 45 DM
(In German)

Key Words: Fatigue life, Traction drives, Linings, Elastic properties

Cylindrical traction drives are used for transmitting motion and power. They consist of two mating wheels whose surfaces touch and transmit power frictionally. In the traction drives under investigation the main cylinder has a lining of acrylonitrile-butadiene polymer mixture. The opposing cylinder is made out of steel. The service life of the traction life depends on the fatigue strength of the lining. A statistical method for the evaluation of fatigue of this lining is presented.

82-1263
Fatigue Failure Criteria for Unidirectional Fiber Composites

Z. Hashin
Dept. of Solid Mechanics, Materials and Structures, Tel Aviv Univ., Ramat-Aviv, Tel Aviv 69978, Israel, J. Appl. Mechanics, Trans. ASME, 48 (4), pp 846-852 (Dec 1981) 10 figs, 10 refs

Key Words: Fatigue life, Fiber composites, Composite materials

Three-dimensional fatigue failure criteria for unidirectional fiber composites under states of cyclic stress are established in terms of quadratic stress polynomials which are expressed in terms of the transversely isotropic invariants of the cyclic stress. Two distinct fatigue failure modes, fiber mode and matrix mode, are modeled separately. Material information needed for the failure criteria are the S-N curves for single stress components. A preliminary approach to incorporate scatter into the failure criteria is presented.

82-1264
Fatigue of Two-Year Weathered A588 Stiffeners and Attachments

I.M. Friedland, P. Albrecht, and G.R. Irwin
Stone and Webster Engrg. Corp., Cherry Hill, NJ, ASCE J. Struc Div., 108 (ST1), pp 125-144 (Jan 1982) 10 figs, 8 tables, 9 refs

Key Words: Fatigue life, Steel, Stiffened structures

An experimental program examined the effect of A588 steel specimens with transverse stiffeners and attachments.

It was found that two years of continuous weathering, prior to stress cycling to failure, reduced the fatigue life of the specimens with stiffeners and attachments by 19 and 6 percent, respectively, as compared to the nonweathered control specimens. Two years of alternating between 6-month weathering and one-quarter-life stress cycling had no significant effect on the fatigue life.

82-1265
Fatigue Reliability: Development of Criteria for Design

The Committee on Fatigue and Fracture Reliability of the Committee on Structural Safety and Reliability of the Structural Division, ASCE J. Struc. Div., 108 (ST1), pp 71-88 (Jan 1982) 5 figs, 2 tables, 32 refs

Key Words: Fatigue life, Reliability, Design techniques

This paper summarizes how criteria for assuring integrity against fatigue and fracture may be developed using principles of engineering reliability analysis as a basis. The probabilistic treatment allows specification-writing groups to consider explicitly uncertainties that affect fatigue performance and fracture susceptibility when setting practical criteria for design. However, this treatment need not lead to more complex provisions at the design level. Several illustrations of these concepts are given.

82-1266
Fatigue Reliability: Variable Amplitude Loading

The Committee on Fatigue and Fracture Reliability of the Committee on Structural Safety and Reliability of the Structural Division, ASCE J. Struc. Div., 108 (ST1), pp 47-69 (Jan 1982) 5 figs, 4 tables, 79 refs

Key Words: Fatigue life, Reliability, Variable amplitude excitation, Random excitation, Crack propagation

Models which designers use to predict fatigue under variable amplitude and random loading are summarized. Basic terminology associated with random process theory is presented. Models for computing fatigue damage associated with various statistical distributions of stress ranges are reviewed. The Palmgren-Miner rule is described and statistical summaries which provide a description of the performance of Miner's rule is presented. A closed form expression for fatigue damage under wide band stress spectra is given. Methods of predicting fatigue crack growth under variable amplitude stresses are reviewed.

82-1267
Fatigue Reliability: Introduction

The Committee on Fatigue and Fracture Reliability of the Committee on Structural Safety and Reliability of the Structural Division, ASCE J. Struc. Div., 108 (ST1), pp 3-23 (Jan 1982) 11 figs, 4 tables, 49 refs

Key Words: Fatigue life, Reliability, Reviews

This paper reviews fatigue models commonly used by designers, e.g., the characteristic S-N curve for high cycle fatigue and the general strain life relationship for low cycle fatigue as well as the fracture mechanics approach. Statistical models (i.e., the Weibull and lognormal) used to describe the distribution of cycles to failure fatigue data, are summarized. An example of analysis of S-N data is presented.

82-1268
Fatigue Reliability: Quality Assurance and Maintainability

The Committee on Fatigue and Fracture Reliability of the Committee on Structural Safety and Reliability of the Structural Division, ASCE J. Struc. Div., 108 (ST1), pp 25-46 (Jan 1982) 5 figs, 1 table, 114 refs

Key Words: Fatigue life, Reliability

Periodic reevaluation of a structure by inspection and proof loading with repair when needed is an alternative to complete dependence on initial quality for obtaining structural reliability. The theory of reliability of fatigue sensitive structures in service is developed. Changes in the probability density functions for strength and fatigue crack length under programs of proof loading or inspection are illustrated. Proof loading truncates the lower tail of the strength distribution. Inspection shifts the distribution upward. The state of the art of inspection for cracks is presented in a review of nondestructive methods and a detailed discussion of visual inspection. Maintenance principles are discussed and several successful repair procedures noted. The economic analysis of inspection and repair programs is outlined.

ELASTICITY AND PLASTICITY

(Also see No. 1313)

82-1269
Amplitude Incremental Variational Principle for Nonlinear Vibration of Elastic Systems

S.L. Lau and Y.K. Cheung

Hong Kong Baptist College, 224 Waterloo Rd., Kowloon, Hong Kong, J. Appl. Mechanics, Trans. ASME, 48 (4), pp 959-964 (Dec 1981) 2 figs, 4 tables, 15 refs

Key Words: Nonlinear vibrations, Periodic response, Incremental methods, Variational methods, Elastic systems, Plates, Shells

The incremental method has been widely used in various types of nonlinear analysis, however, it has received little attention in the analysis of periodic nonlinear vibrations. In this paper, an amplitude incremental variational principle for nonlinear vibrations of elastic systems is derived. Based on this principle various approximate procedures can be adapted to the incremental formulation. The linear solution for the system is used as the starting point of the solution procedure and the amplitude is then increased incrementally. Within each incremental step, only a set of linear equations has to be solved to obtain the data for the next stage. To show the effectiveness of the present method, some typical examples of nonlinear free vibrations of plates and shallow shells are computed. Comparison with analytical results calculated by using elliptic integral confirms that excellent accuracy can be achieved. The technique is applicable to highly nonlinear problems as well as problems with only weak nonlinearity.

82-1270

The Application of Endochronic Plasticity Theory in Modeling the Dynamic Inelastic Response of Structural Systems

H.C. Lin, B.J. Hsieh, and R.A. Valentin
Components Tech. Div., Argonne Natl. Lab., Argonne, IL 60439, Nucl. Engrg. Des., 66 (2), pp 213-221 (Aug 1981) 8 figs, 32 refs

Key Words: Finite element technique, Computer programs, Dynamic structural analysis, Plasticity theory

The endochronic theory of plasticity proposed by Valanis has been applied in predicting the inelastic responses of structural systems. A recently developed convected coordinates finite-element program has been modified to use an endochronic constitutive law. A series of sample problems for a variety of dynamic loadings are presented. The calculations that have been performed comparing classical and endochronic plasticity theories have revealed that the endochronic approach can result in a substantial reduction in computer time for equivalent solution accuracy. This result, combined with the apparent accuracy of material representation indicates that the use of endochronic plasticity has great potential in evaluating the dynamic response of structural systems.

82-1271

Reflection and Transmission of Acoustic Wideband Plane Waves by Layered Viscoelastic Media

P.R. Stepanishen and B. Strozeski
Dept. of Ocean Engrg., Univ. of Rhode Island, Kingston, RI 02881, J. Acoust. Soc. Amer., 71 (1), pp 9-21 (Jan 1982) 11 figs, 1 table, 9 refs

Key Words: Viscoelastic media, Transfer matrix method, Fourier transformation, Sound waves, Sound reflection, Sound transmission

The reflection and transmission of acoustic wideband plane waves by layered viscoelastic media is addressed via the use of transfer matrix and Fourier transform methods. Both the reflected and transmitted time dependent pressures are expressed as convolution integrals which involve the incident pressure and a reflected or transmitted impulse response, respectively. The impulse responses are equivalent to the inverse Fourier transforms of the pressure reflection and transmission coefficients which are obtained by transfer matrix methods for layered viscoelastic media. Numerical results for reflected and transmitted pressures are presented to illustrate the nature of the precursors and the distortion of the incident pulse as a function of incident angle and layer configuration. These results, which were obtained via the use of FFT methods, illustrate the effect on the reflected and transmitted pressures of losses within the layers.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

(Also see Nos. 1289, 1308, 1309, 1314)

82-1272

Dynamic Surface-Pressure Instrumentation for Rods in Parallel Flow

T.M. Mulcahy, W. Lawrence, and M.W. Wambsganss
Components Tech. Div., Argonne Natl. Lab., Argonne, IL 60439, Exptl. Mechanics, 22 (1), pp 31-36 (Jan 1982) 6 figs, 10 refs

Key Words: Measuring instruments, Measurement techniques, Fluid-induced excitation, Rods, Nuclear reactor components

Methods employed and experience gained in measuring random fluid-boundary-layer pressures on the surface of a

small-diameter cylindrical rod subject to dense, nonhomogeneous, turbulent, parallel flow in a relatively noise-contaminated flow loop are described. Emphasis is placed on identification of instrumentation problems, description of transducer construction and mounting, and the pretest calibration required to achieve instrumentation capable of reliable data acquisition.

82-1273

Applications of Systems Theory to Structural Analysis

H.J. Weaver

Lawrence Livermore Natl. Lab., CA, Rept. No. UCRL-53094, 57 pp (July 1981)
DE81028496

Key Words: Transfer functions, Fast Fourier transform, Vibration analysis

The transfer function model of a structure can be used to predict the response motions of the structure resulting from either a single loading or combination of loading, or forcing, conditions or a combination of the two. The use of transfer function models has two main advantages. First, because the models are used in conjunction with frequency domain, or Fourier analysis techniques, tremendous computational efficiency via the fast Fourier transform algorithm is possible. Second, a model can be constructed directly from data obtained by simple vibrational tests performed on a structure.

82-1274

Pulse Interval Measurement -- A Versatile Measuring Process (Pulsabstandmessung - ein vielseitiges Messverfahren)

H. Buschmann

Institut f. Elektromechanische Konstruktionen der Technischen Hochschule Darmstadt, Darmstadt, Germany, Feinwerk u. Messtechnik, 89 (8), pp 379-383 (Dec 1981) 12 figs, 3 refs
(In German)

Key Words: Pulse analyzers

Angular velocity errors, band velocity fluctuations, load angle instability, transmission oscillations and more - these are all measuring problems where temporary coordinations of various processes towards each other or towards a time scale have to be investigated. A measuring process which clearly shows this coordination is described. An analogously operating device with max. 50 kHz feed frequency, is relatively fast, its expenditure slight. A digital device is slower and more expensive, but it can calculate the measurement results in real-time so that, for example, with a quartz-controlled synchronous clock, in addition to the behavior of the load angle, the temporal course of the turning moment can be registered without having to actually interfere with the clock works.

82-1275

Synchronization Problems in Dynamic Holographic Photoelasticity

J.-P. Lallemand

Lab. of Mechanic of Solids, Univ. of Poitiers, France, Exptl. Mechanics, 21 (12), pp 477-480 (Dec 1981) 7 figs, 1 table, 15 refs

Key Words: Photoelastic analysis, Holographic techniques

An analysis of synchronization problems encountered when recording transient-fringe patterns which are dependent on the light source and the method of shock generation is presented. The analysis is specifically designed to be valid on a photoelastic material having either a high or low Young's modulus when the shock generator is an air gun and the light source is a Q-switched ruby laser. Synchronization is performed using integrated circuits in T.T.L. logic which give a triggering order to the ruby laser under the control of the projectile velocity.

82-1276

Acoustic Impedance Measurement Methods

R. Singh

Mech. Engrg. Dept., Ohio State Univ., 206 W. 18th Ave., Columbus, OH 43210, Shock Vib. Dig., 14 (2), pp 3-9 (Feb 1982) 1 table, 82 refs

Key Words: Acoustic impedance, Measurement techniques, Reviews

Acoustic impedance measurements pose a fundamental measurement problem because of the two primary variables, acoustic pressure and particle/volume velocity, only pressure can be measured reliably and accurately in the plane wave regime. Conversely, particle/volume velocity cannot generally be measured at any arbitrary point. Investigators have thus been forced to devise indirect means for measuring acoustic impedances and other characteristics. The most commonly used method is the standing wave tube method, but its limitations have forced investigators to search for alternate

experimental methods. Some of these use digital instrumentation. This paper is a critical review and comparative assessment of these measurement methods.

82-1277

Wave Propagation and Resonance in Piezoelectric Materials

B.A. Auld

Edward L. Ginzton Lab., Stanford Univ., Stanford, CA 94305, J. Acoust. Soc. Amer., 70 (6), pp 1577-1585 (Dec 1981) 11 figs, 15 refs

Key Words: Wave propagation, Resonance, Piezoelectricity

The two basic physical phenomena involved in all piezoelectric devices are wave propagation and resonance. A general review is presented of the connection between piezoelectricity and crystal symmetry, noting that a recent arrival on the scene (ferroelasticity) is intimately related to crystal symmetry rules for piezoelectricity and promises to be applicable to new devices in the future. Special features peculiar to wave propagation in piezoelectric materials are noted and a brief sketch is given of methods used for solving piezoelectric boundary value problems.

82-1278

Time-Average In-Plane Moire Method for the Analysis of Nonsinusoidal Cyclic Loading

C.J. Lin and F.P. Chiang

Nuclear Tech. Inc., San Jose, CA 95119, Exptl. Mechanics, 22 (2), pp 64-68 (Feb 1982) 4 figs, 4 refs

Key Words: Random vibration, Moire effects

A thorough analysis of time-average in-plane moire method for nonsinusoidal vibration is presented. The fringe orders of nonsinusoidal vibration are different from those of sinusoidal ones. There are two ways to determine the fringe order of nonsinusoidal functions.

82-1279

The Decrease of Temperature Error in Linear Displacement Transducer by Means of the Vibrating String (Die Unterdrückung des Temperaturfehlers bei der linearen Wegumformung mit Hilfe der schwingenden Saite)

D. Bouts

a Girard, Duravel, F-46700 Puy L'Eveque, Germany, Tech. Messen-TM, 48 (12), pp 415-419 (Dec 1981) 5 figs, 5 refs
(In German)

Key Words: Displacement transducers, Error analysis, Temperature effects

The design of a new frequency analog displacement transducer based on a vibrating string is described. A temperature compensation frame is introduced to decrease the temperature error.

DYNAMIC TESTS

(Also see Nos. 1331, 1332, 1333, 1334, 1335)

82-1280

Development of a Self-Streamlining Flexible Walled Transonic Test Section

M.J. Goodyer and S.W.D. Wolf

The Univ. of Southampton, Southampton, UK, AIAA J., 20 (2), pp 227-234 (Feb 1982) 13 figs, 21 refs

Key Words: Wind tunnel testing, Computer-aided techniques

This design eliminates the uncertainties found in data from conventional ventilated transonic test sections. The sidewalls are rigid, and the flexible floor and ceiling are positioned by motorized jacks controlled by an on-line computer to minimize tunnel setting times. The tunnel-computer combination is self-streamlining without reference to the model. Data are taken from the model only when the walls are good streamlines, and can be corrected for the small known but inevitable residual interferences. Two-dimensional validation testing in the Mach range up to about 0.85 where the walls are just supercritical shows good agreement with reference data using a height-chord ratio of 1.5. The work has demonstrated the feasibility of almost eliminating wall interferences, allowing advantage to be taken of the improved flow quality and reduced power requirements or increased Reynolds number inherent with a shallow unventilated test section.

82-1281

An Improved Hammer-Impact Technique for Strong Shear Wave Generation

T. Maiguma

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Earthquake Engrg. Struc. Dyn., 10 (1), pp 123-133 (Jan-Feb 1982) 10 figs, 14 refs

Key Words: Testing techniques, Shear waves, Seismic waves, Wave generation

As part of fundamental research on seismic energy sources, a series of experiments was made to improve the field procedures for producing SH waves by using the so-called plank-striking method and also to develop more adequate techniques to generate high-energy shear waves. Based on the results obtained, a flexible impact device which is similar to a slingshot was made to apply a relatively strong impulse at the surface of the ground. This shear wave generator was demonstrated to have desired features in its low cost operation, easy repeatability, high reproducibility and relatively large output strength. Such a shear source, therefore, provides a useful means of evaluating dynamic characteristics of the foundation soils accurately and economically.

82-1282

Introduction to Problems of Structural Dynamics Verification

E. Nellessen

European Space Res. and Tech. Centre (ESTEC), Noordwijk, The Netherlands, Recent Advances in Space Structure Design -- Verification Techniques, Proc. Presentation held at ESTEC, Noordwijk, The Netherlands, April 27-28, 1981, European Space Agency ESA SP 1036, Oct 1981, pp 1-8, 10 figs, 10 refs

Key Words: Testing techniques, Spacecraft, Launching, Simulation

The need to design larger, lighter and more complicated space structures, to reduce cost and to increase safety, requires a general increase in design verification capability. This concerns in particular the consideration of dynamic coupling between launch vehicle and payload for design load definition and the simulation of flight loads for test purposes with respect to their transient nature and multi-degree of freedom characteristics. The improvement of current techniques and the development of alternative concepts are the objectives of the work summarized in this paper.

82-1283

Methodology of Uniaxial Transient Vibration Test for Satellites

B. Boissin, A. Girard, and J.F. Imbert

Centre National d'Etudes Spatiales - Toulouse, France, Recent Advances in Space Structure Design -- Verification Techniques, Proc. Presentation held at ESTEC, Noordwijk, The Netherlands, April 27-28, 1981, European Space Agency ESA SP 1036, Oct 1981, pp 35-54, 30 figs, 19 refs

Key Words: Satellites, Spacecraft, Testing techniques, Vibration tests

For most of the low frequency dynamic flight environment of a satellite, transient testing minimizes the risk of under or overtesting inherent to conventional sine testing. As feasibility of such tests on uniaxial electrodynamic shakers recently proved, the problem is now the dependence of the test specification on possible variations of launch vehicle and satellite dynamic characteristics. Realistic data for thrust transient, launch vehicle and satellite characteristics are defined and dynamic response analysis is performed after a survey of current methods. Possible variations of parameters are then defined and a sensitivity analysis is performed after a survey of current methods. It is found that the frequency variations have the largest influence and must be considered simultaneously. A numerical procedure is developed to compute a worst shock spectrum envelope.

82-1284

Achievements in Multi-Axes Testing Using IABG Servohydraulic Vibration System

W. Raasch

Industrienlagen-Betriebsgesellschaft GmbH, Ottobrunn, Germany, Recent Advances in Space Structure Design -- Verification Techniques, Proc. Presentation held at ESTEC, Noordwijk, The Netherlands, April 27-28, 1981, European Space Agency ESA SP 1036, Oct 1981, pp 55-71, 25 figs, 2 tables, 6 refs

Key Words: Testing techniques, Vibration tests, Spacecraft components

A series of tests with IABG-multi-axes-vibration table was carried out to prove the limitations of reproducing specified acceleration time histories in three dimensions.

82-1285

On the Development of Effective Vibration Screens

A.J. Curtis

Hughes Aircraft Co., Culver City, CA, J. Environ. Sci., 25 (1), pp 16-18 (Jan/Feb 1982) 3 figs, 6 refs

Key Words: Equipment, Vibration tests

The past decade has witnessed an ever-increasing emphasis on the development of environmental stress screens for electronic hardware. Such screens are used as a part of the manufacturing process to remove manufacturing defects and eliminate infant mortality failures from hardware prior to delivery to the use environment. The basic objective is to improve the field reliability and reduce logistic costs to the owner. Decreased manufacturing costs may also be attained. This article reviews the present status of vibration screen development and suggests a manner in which screens may be prescribed with greater precision.

82-1286

Dynamic Analysis and Modelling of Electrodynamic Vibration Test Facilities Applied to the IABG 160 kN System

T. Ogüt and K. Mühlbauer

Industrieanlagen-Betriebsgesellschaft, Ottobrunn, Germany, Recent Advances in Space Structure Design -- Verification Techniques, Proc. Presentation held at ESTEC, Noordwijk, The Netherlands, April 27-28, 1981, European Space Agency ESA SP 1036, Oct 1981, pp 9-26, 32 figs, 5 tables, 14 refs

Key Words: Test facilities, Vibration tests, Mathematical models, Spacecraft

Mathematical dynamic models of a typical electrodynamic vibration exciter and of a slip table including its hydrostatic bearings are presented which may be coupled with test structure models in order to investigate problems of real vibration testing. Several of the model parameters were determined by direct measurement or calculation. Most of them were obtained by fitting the calculated responses to the corresponding results of various dynamic tests performed with the test facility. A survey is given on the basic modeling procedure, the tests and analyses performed, and the models finally established. The future utilization of these models is briefly outlined.

DIAGNOSTICS

(Also see No. 1328)

82-1287

Acoustic Waveguide Technique for Sensing Incipient Faults in Underground Power-Transmission Cables: Including Acoustic-Optic Techniques. Final Report

R.T. Harrold

Westinghouse Res. and Dev. Ctr., Pittsburgh, PA, Rept. No. DOE/ET/29335-T1, 66 pp (Sept 1981) DE81029626

Key Words: Diagnostic techniques, Failure detection, Cables, Underground structures, Acoustic emission, Acoustic absorption, Waveguides

The feasibility of using acoustic waveguide techniques for sensing incipient faults in underground power transmission cables was determined. Theoretical and practical studies were made of both the acoustic emission spectrum signatures associated with cable incipient faults, and the attenuation of acoustic waves in waterfilled metal tubes used as waveguides. Based on critical data, it can be estimated that in favorable circumstances, the acoustic waveguide system would only be useful for sensing incipient faults in underground cables of approx. 800 meters or less in length.

82-1288

Crack Location by Means of Surface Acoustic Intensity Measurements

G.H. Koopmann and J.C. Perraud

Univ. of Houston, Houston, TX, ASME Paper No. 81-WA/NCA-6

Key Words: Crack detection, Acoustic detection, Finite element technique

A computational method for predicting the surface acoustic intensity of a structure is combined with a structural finite element program to study the extent to which the propagation of crack along the boundary of the flat plate affects its radiation characteristics. The results of examining the first four plate modes show interesting cases where small changes in the structural modes frequency and geometry produce large changes in the corresponding surface acoustic intensity which would be easily detectable by an acoustic intensity meter.

82-1289

Measurement and Equalization of the Frequency Response of Non-ideally Coupled Accelerometers (Messung und Korrektur des Frequenzganges nichtidealer Ankopplungen von Beschleunigungsaufnehmern)

H. Hog, K. Kroschel, and H.-E. Meier

Techn. Messen-TM, 48 (12), pp 407-413 (Dec 1981) 16 figs, 9 refs
(In German)

Key Words: Accelerometers, Frequency filters, Diagnostic techniques, Error analysis

For the acoustical test of machines the output signal of an accelerometer is used. Depending on the method by which the accelerometer is coupled to the machine the amplitude response becomes frequency dependent which complicates the analysis of the output signal. The measured frequency responses are equivalent to a system of 2nd order which were equalized by a filter with up to 5 parameters.

BALANCING

82-1290
A General Mass Balancing Method for Complex Planar Mechanisms
J.L. Elliott and D. Tesar
Milliken Res. Corp., Spartanburg, SC 29304, Mech. Mach. Theory, 17 (2), pp 153-172 (1982) 9 figs, 1 table, 9 refs

Key Words: Balancing techniques, Mechanisms

The 1968 work by Berkof and Lowen provided a new perspective in the balancing of machines by using linearly independent vectors for the complete shaking force balancing of simple mechanisms. As logical extensions of their work, methods presented in this paper allow the complete balancing of complex mechanisms for shaking force or shaking moment (which inherently satisfies the shaking force criteria). These methods further allow the satisfaction of user specified non-zero values of the dynamic properties of the mechanism including driving torque, shaking momentum, shaking force, or combinations of these. The formulation provides, by direct non-iterative computation, redistribution of the mass content of the system in the most general sense to enhance the operating smoothness of the total system. These synthesis results are addressable by all designers since their uniform mathematical formulation can be packaged in compact interactive computational programs for all conceivable dynamic properties to be considered for balancing.

MONITORING

82-1291
Introduction to Acoustic Emission
L.X. Nepomuceno
Orplan/Sonica Inspecoes Industriais Ltda., Sao Paulo, Brazil, 20 pp (Oct 7, 1981) (Presented at 2nd Seminar on Nondestructive Testing of Abende: Brazilian Assoc. for Nondestructive Testing, San Paulo, Brazil, Oct 5-7, 1981)
N81-33493
(In Portuguese)

Key Words: Acoustic emission, Monitoring techniques

An elementary introduction to the acoustic emission techniques are presented with emphasis on the fundamental aspects that govern the process. A brief historical review is given on how the technqiue is developed. Some of the practical applications covered are: materials properties research; monitoring and characteristics of structures; and applications in weldments quality control and monitoring.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

82-1292
A Logical Function Method for Dynamic and Design Sensitivity Analysis of Mechanical Systems with Intermittent Motion
P.E. Ehle and E.J. Haug
Office of the Chief of Staff, U.S. Army, Washington, DC, J. Mech. Des., Trans. ASME, 104 (1), pp 90-100 (Jan 1982) 10 figs, 3 tables, 6 refs

Key Words: Dynamic structural analysis, Intermittent motion, Mechanisms

Dynamic and design sensitivity analysis of mechanisms and machines with intermittent motion are accomplished through introduction of logical functions to approximate discontinuities and special features of system motion. The Heaviside step function and the delta and unit doublet distributions are introduced to represent discontinuities and to determine the values of certain functions of isolated times. These functions and distributions are approximated by smooth functions, and validity of the approximation is argued both mathematically and physically. A numerical method is presented for analysis of the approximate problem. An elementary and a complex, realistic example are presented to illustrate applications of the method.

82-1293

Alongwind Response Estimation: Closed Form Solution

G. Solari
Instituto di Scienza delle Costruzioni, Univ. of Genova, Genova, Italy, ASCE J. Struc. Div., 108 (ST1), pp 225-244 (Jan 1982) 6 figs, 2 tables, 17 refs

Key Words: Wind-induced excitation, Turbulence

The problem of dynamic alongwind response of structures to forces induced by atmospheric turbulence is treated in this paper. Starting from the classical formulation, the study analyzes the behavior of two structural standard models, called point-like and three dimensional, respectively. The treatment of the problem leads to a closed form expression of the alongwind response. The remarkable simplicity and the very high precision of the proposed method is pointed out in general terms and illustrated by two examples.

82-1294

Generalized Wave Equation in Finite Domains

H.D. Fisher
Mech. Engrg. Dept., Combustion Engrg., Inc., Windsor, CT 06095, ASCE J. Engrg. Mechanics Div., 108 (EM1), pp 155-163 (Feb 1982) 27 refs

Key Words: Wave equation, Wave propagation

A generalized equation governing one dimensional wave propagation in finite domains is solved by employing the finite Sturm-Liouville transform. The formulation includes the effects of time dependent boundary conditions, non-zero initial conditions and the presence of body or surface forces or both. The modal solutions for the dynamic response are valid for the entire range of the temporal variable. The utility of the analysis is demonstrated by citing more than twenty references in which the derived time dependent response can readily be obtained from the generalized solutions presented here.

82-1295

A New Method of Computation of Wave Fields Using Gaussian Beams

M.M. Popov
V.A. Steklov Mathematical Inst., Academy of Sciences of the USSR, Leningrad Branch, Leningrad 191011, USSR, Wave Motion, 4 (1), pp 85-97 (Jan 1982) 20 refs

Key Words: Wave propagation, High frequencies

A new method of computation of wave fields of different physical nature in the high-frequency approximation is proposed. The method, based on summation of Gaussian beams, enables us to compute the wave fields on arbitrary caustics without introducing any special functions. The three-dimensional point source problem for the Helmholtz equation is considered and all necessary formulas of the method are presented. The computation algorithm is discussed in detail on the basis of these formulas.

82-1296

Dynamic Solutions for the Non-Uniform Motion of an Edge Dislocation

L.M. Brock
Dept. of Engrg. Mechanics, Univ. of Kentucky, Lexington, KY 40506, Intl. J. Engrg Sci., 20 (1), pp 113-118 (1982) 2 figs, 15 refs

Key Words: Edge effect, Wave propagation

The fully dynamic analysis for the largely arbitrary motion of an edge dislocation yields exact solutions for the displacements. A study of the dislocation path shear stress shows that the singularity order drops when the dislocation moves at the Rayleigh wave speed, or supersonically. Numerical results for the dislocation path shear stress are presented for the physically important constant-speed dislocation case.

82-1297

Generalized Coordinate Partitioning for Dimension Reduction in Analysis of Constrained Dynamic Systems

R.A. Wehage and E.J. Haug
Materials Div., College of Engrg., Univ. of Iowa, Iowa City, IA 52242, J. Mech. Des., Trans. ASME, 104 (1), pp 247-255 (Jan 1982) 13 figs, 2 tables, 21 refs

Key Words: Dynamic structural analysis, Equations of motion, Differential equations, Holonomic systems, Tracked vehicles

A computer-based method for formulation and efficient solution of nonlinear, constrained differential equations of motion for mechanical systems is presented. Nonlinear

holonomic constraint equations and differential equations of motion are written in terms of a maximal set of Cartesian generalized coordinates, to facilitate the general formulation of constraints and forcing functions. A Gaussian elimination algorithm with full pivoting decomposes the constraint Jacobian matrix, identifies dependent variables, and constructs an influence coefficient matrix relating variations in dependent and independent variables. This information is employed to numerically construct a reduced system of differential equations of motion whose solution yields the total system dynamic response. A numerical integration algorithm with positive-error control, employing a predictor-corrector algorithm with variable order and step size, is developed that integrates for only the independent variables, yet effectively determines dependent variables. Numerical results are presented for planar motion of two tracked vehicular systems with 13 and 24 degrees of freedom. Computational efficiency of the algorithm is shown to be an order of magnitude better than previously employed algorithms.

82-1298

The Generalized Coordinate Selection for the Dynamics of Complex Planar Mechanical Systems

R.A. Freeman and D. Tesar

Wayne H. Colony Co., Tallahassee, FL, J. Mech. Des., Trans. ASME, 104 (1), pp 206-217 (Jan 1982) 7 figs, 4 tables, 14 refs

Key Words: Dynamic structural analysis, Equations of motion

This paper involves the most appropriate selection of the reference parameters (generalized coordinates) to develop the controlling equations for a large class of complex multi-degree of freedom planar mechanical systems. The selection of the reference parameter for the 1 DOF system is shown to be a simple matter since the modeling components can be transferred between reference parameters with a very simple set of equations. For multi-degree of freedom systems, the development of the controlling equations is shown to be direct as long as the structure is made up of two link Assur groups or dyads. The controlling equations remain transparent and therefore are ideal for treating the coupling and design questions for adjustable mechanisms as well as for robotic type systems.

82-1299

Quadratic Integrals for Linear Nonconservative Systems and Their Connection with the Inverse Problem of Lagrangian Dynamics

W. Sarlet and L.Y. Bahar

Instituut voor Theoretische Mechanica, Rijksuniversiteit Gent, Krijgslaan 271-S9, B-9000 Gent, Belgium, Intl. J. Nonlin. Mechanics, 16 (3/4), pp 271-281 (1981) 14 refs

Key Words: Dynamic systems, Time-dependent parameters, Integral equations

The direct method for the construction of first integrals is applied to a system of second-order ordinary differential equations with time-varying coefficients. The connection between the existence of a Lagrangian and the problem of finding quadratic integrals, surmised in previous papers because of specific results, is rigorously established. Finally, the approach is illustrated by obtaining all the known quadratic integrals for a time-dependent n-dimensional harmonic oscillator from a single expression.

82-1300

Investigation of the Stability of Singular Points with Discontinuous Forces by Means of Potential Energy (Das Studium der Stabilität singulärer Punkte, in welchen die Kräfte unstetig sind mit Hilfe des Potentials)

H.J. Kelpp

Lehrstuhl f. Mechanik I, Ruhr-Universität, 4630 Bochum, Germany, Intl. J. Nonlin. Mechanics, 16 (3/4), pp 263-290 (1981) 5 figs, 1 table, 5 refs
(In German)

Key Words: Single degree of freedom systems, Heaviside functions

The potential energy of a conservative system with one degree of freedom on which act discontinuous forces is expressed with the help of the Heaviside function. The stability of the singular points in which the forces are discontinuous is investigated. With the potential energy special functions are established. The values of these functions in such a singular point determine the stability of the point. The representation of these values in a plane permits one to establish regions of system parameter values corresponding to stable and unstable equilibrium positions. The method is illustrated by an example.

82-1301

A Periodically Forced Scalar Ordinary Differential Equation

P. Holmes and D. Lewis

Dept. of Theoretical and Appl. Mechanics, Cornell Univ., Ithaca, NY 14853, Intl. J. Nonlin. Mechanics, 16 (3/4), pp 233-246 (1981) 8 figs, 11 refs

Key Words: Differential equations, Periodic excitation

Topological and classical methods are used to study the first order periodically excited differential equation, $\dot{x} = f(x) + \mu g(t)$. Given suitable conditions on f(x), results are proved on the number, stability and bifurcations of periodic orbits. Several examples are given to illustrate both the use of qualitative techniques and errors which may arise from the application of classical methods.

82-1302

An Approach to Studies of the Stability in the Large

A. Tondl

Natl. Res. Inst. for Machine Des., 250 97 Prague, Czechoslovakia, Intl. J. Nonlin. Mechanics, 16 (3/4), pp 259-279 (1981) 15 figs, 11 refs

Key Words: Stability, Nonlinear systems

Methods of investigating the stability in the large (i.e. for disturbances which are not small) of nonlinear systems are presented for the case of a non-unique solution with the disturbances specified in terms other than the initial conditions. The disturbances considered in the analysis succeed one another after time intervals which are so long that the transient motion tends to be stationary; they can be either wholly determined or stochastic.

82-1303

Spectral/Critical Speed Characteristics of Structure Subject to Moving Loads

J. Padovan

Univ. of Akron, Akron, OH 44325, Intl. J. Engrg. Sci., 20 (1), pp 77-91 (1982) 18 refs

Key Words: Eigenvalue problems, Moving loads, Critical speeds, Spectrum analysis

Through the use of a family of generalized Rayleigh quotients, this paper considers the influence of nonstationary time dependent loads/disturbances on the spectral characteristics of structure modeled by 3-D nonpolar elasticity theory wherein the fields are treated as small excursions superposed on large. To generalize the results, the influence of nonconservatism and generalized inertia fields are admitted. The main emphasis of the work is given to determining the various properties of the eigenvalue problem arising out of such nonstationary loading situations. This includes ascertaining the occurrence of various types of spectral/critical speed shifts/bifurcations induced by moving disturbances. As a further extension of the work, the results are specialized to the eigenvalue problem arising from nonconservative gyroscopic FE simulations of moving load problems.

82-1304

Connection Force Analysis of Mechanisms Described by Explicit Equations of Motion in Generalized Coordinates

R.R. Allen and J.P. Harrell

Mechanics and Structures Dept., School of Engrg. and Appl. Sci., Univ. of California, Los Angeles, CA 90024, J. Mech. Des., Trans. ASME, 104 (1), pp 168-174 (Jan 1982) 12 figs, 9 refs

Key Words: Dynamic structural analysis, Equations of motion, Mechanisms, Four bar mechanisms

Connection forces acting at the joints of a kinematic mechanism are derived from the generalized variables of the mechanism equation of motion using an equivalent-force analysis The connection force calculation is numerically efficient and is independent of the formulation and solution of the equations of motion. A numerical example illustrates an application to a planar four-bar linkage.

82-1305

Determination of Complex Characteristic Values and Vectors from Sinusoidal Excitations at Near Resonance Frequencies

C.L. Keller

Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH, Rept. No. AFWAL-TR-80-3136, 133 pp (June 1981)
AD-A105 624

Key Words: Iteration, Periodic excitation, Periodic response

An iterative procedure for determining complex characteristic values and vectors from measured values of the steady state response to sinusoidal excitations is described. An extension of the procedure which enables it to cope with the case of two close characteristic values is presented also. Results of numerical experiments performed to investigate these procedures are given.

82-1306

On the Matched-Asymptotic Solution to the Diffraction of a Plane Elastic Wave by a Semi-infinite Stress-free Boundary of Finite Width

K. Viswanathan, J.P. Sharma, and S.K. Datta
Defence Science Lab., Delhi-110054, India, Wave Motion, 4 (1), pp 1-13 (Jan 1982) 2 figs, 5 refs

Key Words: Elastic waves, Wave diffraction, Edge effect

The diffraction of a plane elastic compressional wave by a semi-infinite rectangular stress-free boundary of finite width is investigated using the method of matched-asymptotics. The outer problems are solved in terms of Wiener-Hopf functions while the inner problems by the Kolosov-Muskhelishvili complex potentials. The two are matched to derive the stress behavior away from the edge of the strip. Numerical results are presented for various angles of incidence of the plane wave.

82-1307

The Inversion of Acoustical Impedance Profile by Methods of Characteristics

F. Santosa and H. Schwetlick
Dept. of Theoretical and Applied Mechanics, Cornell Univ., Ithaca, NY 14853, Wave Motion, 4 (1), pp 99-110 (Jan 1982) 6 figs, 19 refs

Key Words: Wave propagation, Acoustic impedance

The inverse problem for the one-dimensional propagation of waves through a medium with an unknown impedance profile is considered. From the reflected pulses caused by an excitation of short duration, this profile is reconstructed by applying the method of characteristics with finite difference approximations. This leads to a simple and fast algorithm, which is demonstrated by the numerical examples in the paper.

82-1308

Asymptotic Analysis of the Modes of Wave Propagation in a Piezoelectric Solid Cylinder

H.S. Paul and D.P. Raju
Dept. of Math., Indian Inst. of Tech., Madras, 600 036, India, J. Acoust. Soc. Amer., 71 (2), pp 255-263 (Feb 1982) 2 tables, 11 refs

Key Words: Cylinders, Piezoelectricity, Wave propagation, Asymptotic series

An asymptotic method is used to analyze the longitudinal and circumferential modes of wave propagation in a piezoelectric solid circular cylinder. Information obtained in this method is useful for the frequency spectrum at long wavelengths.

82-1309

Spectral Analysis Using the Fast Fourier Transformation (l'Analyse spectrale Par la Transformation de Fourier Rapide)

T. Moreira
Engins Matra, Velizy, France, Rept. No. REPT-100-81, 115 pp (Apr 24, 1981)
N82-10304
(In French)

Key Words: Fast Fourier transform, Spectrum analysis, Signal processing techniques, Computer programs

The Fourier transformation was studied, emphasizing applications in signal analysis. A diminution in run time when calculating the power spectrum of a signal was sought. The utilization of the method is only valid for finding the general nature of spectral oscillations, to the exclusion of any quantitative measure. As a general rule, the calculation method based on the autocorrelation function remains the most effective. As a corollary result, a computer calculation program for the fast Fourier transformation is presented.

82-1310

Seismic Response of Structures by the Response Spectrum Method

A.H. Hadjian
Los Angeles Power Div., Bechtel Power Corp., P.O. Box 60860, Terminal Annex, Los Angeles, CA 90060, Nucl. Engrg. Des., 66 (2), pp 179-201 (Aug 1981) 17 figs, 6 tables, 13 refs

Key Words: Seismic response, Response spectra

The problems of the acceleration profile at the lower elevations of cantilever structures and the response of relatively rigid structrues are explored. It is shown that the use of the conventional methods for the above problems provide very approximate results. An alternative combination of the modal responses is proposed that not only resolves the above problems but also provides better estimates of response for the complete range of structure frequencies. The procedure treats the relative and rigid body responses separately and then appropriately combines the two results.

82-1311

An Iterative Procedure for the Generation of Consistent Power/Response Spectrum

J.F. Unruh and D.D. Kana

Engrg. Sci. Div., Southwest Res. Inst., San Antonio, TX 78284, Nucl. Engrg. Des., 66 (3), pp 427-435 (Sept 1981)

Key Words: Earthquake response, Response spectra, Power spectra, Mappings (mathematics), Iteration

An iterative procedure is presented that allows computation of spectrum-consistent parameters for the description of earthquake/transient motion. The procedure treats the strong motion portion of the earthquake event as being a stationary Gaussian random process, thereby allowing a mapping between the response spectrum and power spectral density function parameters. Several examples of the mapping procedure are presented with comparison to experimental results to demonstrate the validity and usefulness of the approach.

82-1312

On the Use of the Finite Element Method on Some Acoustical Problems

L. Cederfeldt

Ingemansson Acoustics, ABC-Husen, S-217 61 Malmo, Sweden, J. Engrg. Indus., Trans. ASME, 104 (1), pp 108-112 (Feb 1982) 12 figs, 4 refs

Key Words: Finite element technique, Sound propagation, Sound attenuation, Ducts, Curved ducts, Acoustic linings

In a project carried out in 1974-1975, the finite element method was applied on some acoustical problems to illustrate the possibilities of the method. Calculations were made for the following examples: sound attenuation of a lined right angle bend, a lined straight duct, and expansion chamber and the sound reduction of a resilient skin.

82-1313

Cube Isoparametric Rolling/Traveling Finite Elements

I. Zeid and J. Padovan

Dept. of Mech. Engrg., Northeastern Univ., Boston, MA 02115, Computers Struc., 15 (1), pp 11-22 (1982) 18 figs, 2 tables, 15 refs

Key Words: Rolling friction, Finite element technique, Viscoelastic properties, Tires

The development and formulation of a new cubic isoparametric rolling/traveling finite element is described. The element can be used to simulate the dynamic response of steadily rolling/traveling viscoelastic structures without the necessity of numerical time integration of the governing equations. Due to its higher order shape function, the element can more accurately simulate both the inertia and viscoelastic effects associated with rolling/traveling structures than currently available lower order moving elements. To illustrate the capabilities of the new cubic element, comparisons with exact and lower order generated results are presented.

82-1314

Numerical Methods for Harmonic Analysis on the Sphere

O.L. Colombo

Dept. of Geodetic Science, Ohio State Univ., Columbus, OH, Rept. No. DGS-310, SCIENTIFIC-7, AFGL-TR-81-0038, 149 pp (Mar 1981)
AD-A104 178

Key Words: Harmonic analysis, Spheres, Numerical analysis

This report presents some numerical methods for estimating spherical harmonic coefficients from data sampled on the sphere. The data may be given in the form of area means or of point values, and it may be free from errors or affected by measurement noise. The case discussed to greatest length is that of complete, global data sets on regular grids (i.e., lines of latitude and longitude, the latter, at least, separated by constant interval); the case where data are sparsely and irregularly distributed is also considered in some detail.

MODELING TECHNIQUES

(See No. 1286)

PARAMETER IDENTIFICATION

82-1315

A Comparative Study of Recursive Identification Schemes Applied to Vibration Systems

S.A. Zaghlool and M. Tomizuka

Univ. of California, Berkeley, CA, ASME Paper No. 81-WA/DSC-22

Key Words: Parameter identification technique

A comparative study is carried out for implementing digital recursive algorithms to identify the characteristic parameters of vibrating systems. The study includes series parallel, instrumental variable, modified parallel, extended parallel, extended lease square, and autoregressive moving average algorithms.

82-1316
On-Line Algorithms for Initial State Identification in Linear Systems

H. Sehitoglu
Louisiana State Univ., Baton Rouge, LA, ASME Paper No. 81-WA-DSC-7

Key Words: Parameter identification technique

This paper presents on-line algorithms to identify the unknown initial state of a linear system. It is shown that estimation of an initial state vector can be treated as a parameter identification problem. The algorithms are developed by using the equation error identification technique in connection with the Lyapunov design approach. An example problem is considered to illustrate the concepts discussed.

82-1317
Non-Parametric Identification of a Class of Non-Linear Multidegree Dynamic Systems

S.F. Masri, G.A. Bekey, H. Sassi, and T.K. Caughey
School of Engrg., Univ. of Southern California, Los Angeles, CA, Earthquake Engrg. Struc. Dyn., 10 (1), pp 1-30 (Jan-Feb 1982) 31 figs, 47 refs

Key Words: System identification techniques, Random excitation

A non-parametric identification technique is presented for chain-like multidegree-of-freedom nonlinear dynamic systems The method uses information about the state variables of nonlinear systems to express the system characteristics in terms of two-dimensional orthogonal functions. The technique is applied to a model of a steel frame that has been extensively investigated both analytically and experimentally. The method can be used with deterministic or random excitation to identify dynamic systems with arbitrary nonlinearities, including those with hysteretic characteristics. It is also shown that the method is easy to implement and needs much less computer time and storage requirements compared to the Wiener-kernel approach. The method is shown to have low sensitivity to the effects of additive noise in the experimental data.

OPTIMIZATION TECHNIQUES

(See No. 1324)

COMPUTER PROGRAMS

(Also see Nos. 1253, 1257, 1309)

82-1318
Computer Program to Predict Aircraft Noise Levels

B.J. Clark
NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TP-1913, E-733, 146 pp (Sept 1981)
N81-33947

Key Words: Computer programs, Aircraft noise, Noise prediction

Methods developed for predicting the noise contributions from various aircraft noise sources were programmed to predict aircraft noise levels either in flight or in ground tests. The noise sources include fan inlet and exhaust, jet, flap (for powered lift), core (combustor), turbine, and airframe. Noise propagation corrections are available for atmospheric attenuation, ground reflections, extra ground attenuation, and shielding. Outputs can include spectra, overall sound pressure level, perceived noise level, tone-weighted perceived noise level, and effective perceived noise level at locations specified by the user.

82-1319
Probability of Pipe Fracture in the Primary Coolant Loop of a PWR Plant. Volume 9: PRAISE Computer Code User's Manual

E.Y. Lim
Lawrence Livermore Natl. Lab., CA, Rept. No. UCID-18967-VOL-9, 254 pp (Aug 1981)
NUREG/CR-2189-V9

Key Words: Computer programs, Piping systems, Nuclear reactors, Earthquake damage

The PRAISE (Piping Reliability Analysis Including Seismic Events) computer code estimates the influence of earthquakes on the probability of failure at a weld joint in the primary coolant system of a pressurized water reactor. Failure, either a through-wall defect (leak) or a complete pipe severance (a large-LOCA), is assumed to be caused by fatigue crack growth of an as-fabricated interior surface circumferential defect.

82-1320

User's Manuals for DYNA3D and DYNAP: Nonlinear Dynamic Analysis of Solids in Three Dimensions

J.O. Hall

Lawrence Livermore Natl. Lab., CA, Rept. No. UCID-19156, 96 pp (July 1981)
DE81028360

Key Words: Dynamic structural analysis, Computer programs, Finite element technique

This report provides a user's manual for DYNA3D, an explicit three-dimensional finite element code for analyzing the large deformation dynamic response of inelastic solids. A contact-impact algorithm permits gaps and sliding along material interfaces. By a specialization of this algorithm, such interfaces can be rigidly tied to admit variable zoning without the need of transition regions. Spatial discretization is achieved by the use of 8-node solid elements, and the equations-of-motion are integrated by the central difference method.

82-1321

Nuclear Blast Response Computer Program, Volume I. Program Description

J.A. McGrew, J.P. Giesing, T.P. Kalman, H.H. Croxen, and W.P. Rodden

Douglas Aircraft Co., Long Beach, CA, Rept. No. AFWL-TR-81-32-VOL-1, 393 pp (Aug 1981)
AD-A106 480

Key Words: Computer programs, Aircraft, Nuclear explosion effects

The VIBRA-6 computer program is a digital computer program developed to determine the response of aircraft to nuclear explosions when flying at subsonic speeds. It is similar to the VIBRA-4 program but uses the latest Doublet-Lattice Method for obtaining subsonic aerodynamic forces for arbitrary lifting surface-body configurations.

82-1322

Nuclear Blast Response Computer Program. Volume II. Doublet-Lattice and Piston Theory Aerodynamics

J.P. Giesing, T.P. Kalman, W.P. Rodden, H.H. Croxen, and J.A. McGrew

Douglas Aircraft Co., Long Beach, CA, Rept. No. AFWL-TR-81-32-VOL-2, 199 pp (Aug 1981)
AD-A106 481

Key Words: Computer programs, Aircraft, Nuclear explosion effects

The VIBRA-6 computer program is a digital computer program developed to deter the response of aircraft to nuclear explosions when flying at subsonic speeds. It is similar to the VIBRA-4 program but uses the latest Doublet-Lattice Method for obtaining subsonic aerodynamic forces for arbitrary lifting surface-body configurations. The Doublet-Lattice procedure has been extended to account for the moving blast wave by considering it as a traveling gust. The nuclear blast representation remains the same as that used in the VIBRA-4 program but the method of solution of the equations of motion has been changed from that of numerical integration of quasi-steady equations of motion to a Fourier transform procedure to move from frequency domain solutions to time history solutions. The concept of dynamic core has been introduced to the program thus removing any restrictions on the size of the aircraft idealization which can be analyzed.

82-1323

Nuclear Blast Response Computer Program. Volume III. Program Listing

J.A. McGrew, H.H. Croxen, T.P. Kalman, J.P. Giesing, and W.P. Rodden

Douglas Aircraft Co., Long Beach, CA, Rept. No. AFWL-TR-81-32-VOL-3, 433 pp (Aug 1981)
AD-A106 520

Key Words: Computer programs, Aircraft, Nuclear explosion effects

The VIBRA-6 computer program is a digital computer program developed to determine the response of aircraft to nuclear explosions when flying at subsonic speeds. It is similar to the VIBRA-4 program but uses the latest Doublet-Lattice Method for obtaining subsonic aerodynamic forces for arbitrary lifting surface-body configurations. This report is divided into three volumes. Volume I contains the overall program descriptions and method of analysis, the input and output data descriptions, the program operation and a sample problem. Volume II details the unsteady aerodynamic procedure and Volume III contains the program listings.

GENERAL TOPICS

CONFERENCE PROCEEDINGS

82-1324
Optimization of Distributed Parameter Structures
E.J. Haug and J. Cea, editors
Sijthoff and Noordhoff Intl. Publishers, Alphen aan den Rijn, The Netherlands; Rockville, MD, USA, 1981, Vol. 1, 788 pp, ISBN 90 286 2791X; Vol. 2, 860 pp, ISBN 90 286 2791X

Key Words: Optimizaton, Continuous parameter methods, Proceedings

The two volumes on structural optimization problems contain lectures and contributed papers presented at the NATO-NSF Advanced Study Institute, Iowa City, May 21-June 4, 1980. One of the objectives was to promote interaction by engineers and applied mathematicians who have, in the past, taken rather different approaches to structural optimization. Shape optimal design was emphasized in the Institute, to provide a forum for the study of mathematical techniques of shape optimization, and to consider their applicability for structural optimization. In the first volume, the following main topics are presented: optimality criteria methods for structural optimization; numerical optimization methods; optimization of structures under earthquake loads, and finite dimensional structural optimization. The second volume deals with optimization of structures under non-conservative loading and other special problems of distributed parameter structural optimization; the shape optimal design problem, and a thorough treatment of design sensitivity analysis of structural systems. Both volumes include examples and applications.

TUTORIALS AND REVIEWS
(Also see No. 1276)

82-1325
Seismic Waves
S. De
15 Ratanpalli, Santiniketan 731235, Birbhum, W. Bengal, India, Shock Vib. Dig., 14 (1), pp 17-33 (Jan 1982) 197 refs

Key Words: Seismic waves, Reviews

The article reviews recent developments in seismology, mathematical methods to study seismic waves, effects of such waves on ground movement and structures, and prediction of earthquakes. Directions for future research are given.

82-1326
The Literature of Vibration Engineering
N.F. Rieger
Stress Tech. Inc., Rochester, NY. Shock Vib. Dig., 14 (1), pp 5-13 (Jan 1982) 81 refs

Key Words: Reviews, Vibration isolation, Vibration damping, Random vibration, Vibration tests

This article contains a review of available textbooks on mechanical vibrations. Books are identified according to their emphasis -- fundamentals, applied vibrations, isolation and damping, random vibrations, and testing.

CRITERIA, STANDARDS, AND SPECIFICATIONS

82-1327
Development of a Mechanical Equipment Noise-Control Permit Scheme for Model Building Code
W.E. Blazier, Jr., N.P. Miller, and D.A. Towers
Bolt, Beranek and Newman, Inc., Cambridge, MA, Rept. No. EPA-550/9-81-400, 195 pp (Aug 1981) PB82-132523

Key Words: Machinery noise, Noise reduction, Standards and codes

This report deals with the development of noise-control approaches applicable to a mechanical equipment permit scheme for commercial, business, institutional, and residential high-rise buildings. The report identifies and categorizes mechanical equipment as noise sources. The equipment is classified and rank-ordered on the basis of potential noise impact. A series of worksheets and guidelines are presented for use in performing the calculations necessary to evaluate a given mechanical design for exterior noise impact. A mechanical equipment permit scheme is explained for use by a community.

BIBLIOGRAPHIES

82-1328
Acoustic Emission Signal Analysis. January, 1975 - October, 1981 (Citations from the International Information Service for the Physics and Engineering Communities Data Base)
NTIS, Springfield, VA, Rept. for Jan 1975 - Oct 1981, 119 pp (Oct 1981)
PB82-853417

Key Words: Acoustic emission, Signal processing techniques, Bibliographies

This bibliography cites reports on innovative methods, instrumentation, and recording devices for acoustic emission analysis; generation and propagation mechanisms of acoustic emissions; and pattern recognition techniques relative to signal classification technology.

82-1329
Auto and Truck Suspension System, June, 1970 - December, 1981 (Citations from the Engineering Index Data Base)
NTIS, Springfield, VA, Rept. for June 1970 - Dec 1981, 195 pp (Dec 1981)
PB82-857251

Key Words: Shock absorbers, Suspension systems (vehicles), Automobiles, Trucks, Bibliographies

The effect of suspension systems on the performance of motor vehicles is discussed in the cited reports. Topics include shock absorbers, steering stability, and load leveling, as well as the characteristics of both leaf and coil springs. Materials considerations such as fatigue and wear are also discussed.

82-1330
Soil Structure Interactions. 1964 - Oct 1981 (Citations from the NTIS Data Base)
NTIS, Springfield, VA, Rept. for 1964 - Oct 1981, 227 pp (Nov 1981)
PB82-801630

Key Words: Interaction: soil-structure, Pipes (tubes), Tunnels, Underground structures, Hardened installations, Bibliographies

Interactions resulting from loads exerted on soils and structures are reviewed. Such diversified structures as tunnels, conduits, pipes, piles, hardened installations, and plow blades are covered. Loads resulting from nuclear explosions as well as physical loads are investigated. Earthquake contributing loads are excluded.

82-1331
Nondestructive Testing of Composite Materials. January, 1970 - October, 1981 (Citations from the NTIS Data Base)
NTIS, Springfield, VA, Rept. for Jan 1970 - Oct 1981, 165 pp (Oct 1981)
PB82-854134

Key Words: Composite materials, Nondestructive tests, Bibliographies

This bibliography contains citations concerning the nondestructive techniques for testing or examining a wide variety of composite materials for the detection of flaws or defects which affect their mechanical properties and behavior.

82-1332
Nondestructive Testing of Composite Materials. January, 1972 - October, 1981 (Citations from the International Aerospace Abstracts Data Base)
NTIS, Springfield, VA, Rept. for Jan 1972 - Oct 1981, 153 pp (Oct 1981)
PB82-854126

Key Words: Composite materials, Nondestructive tests, Bibliographies

This bibliography contains citations concerning the nondestructive techniques for testing or examing a wide variety of composite materials for the detection of flaws or defects which affect their mechanical properties and behavior.

82-1333
Nondestructive Testing of Ceramics. January, 1972 - October, 1981 (Citations from the International Aerospace Abstracts Data Base)

NTIS, Springfield, V[illegible]t. for Jan 1972 - Oct 1981, 77 pp (Oct 1[illegible]
PB82-854118

Key Words: Ceramic[illegible]structive tests, Bibliographies

This bibliography co[illegible]tains citations concerning nondestructive techniques for testing or examining ceramic materials and ceramic bodies for the detection of flaws or defects.

82-1334
Nondestructive Testing of Ceramics. January, 1970 - October, 1981 (Citations from the NTIS Data Base)
NTIS, Springfield, VA, Rept. for Jan 1[illegible] 1981, 129 pp (Oct 1981)
PB82-854100

Key Words: Ceramics, Nondestructive tests, Bibliographies

This bibliography contains citations concerning the nondestructive techniques for testing or examining ceramic materials and ceramic bodies for the detection of flaws or defects.

82-1335
Nondestructive Testing of Fractures. January, 1972 - October, 1981 (Citations from the International Aerospace Abstracts Data Base)
NTIS, Springfield, VA, Rept. for Jan 1972 - Oct 1981, 204 pp (Oct 1981)
PB82-854159

Key Words: Fracture properties, Nondestructive tests, Bibliographies

This bibliography contains citations concerning the nondestructive techniques for testing or examining fractures in miscellaneous materials and in a wide variety of fabricated objects and equipment. The bibliography also covers theoretical consideration of fracturing processes.

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19-21 12th Intersociety Conference on Environmental Sytems [SAE] San Diego, CA *(SAE Hqs.)*

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15-19 Computer Engineering Conference and Exhibit [ASME] San Diego, CA *(ASME Hqs.)*

16-19 West Coast International Meeting [SAE] San Francisco, CA *(SAE Hqs.)*

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12-14 Petroleum Workshop and Conference [ASME] Philadelphia, PA *(ASME Hqs.)*

12-15 1982 Design Automation Conference [ASME] Washington, DC *(Prof. Kenneth M. Ragsdell, Purdue Univ., School of Mech. Engrg., West Lafayette, IN 47907 - (317) 494-8607)*

13-16 International Off-Highway Meeting & Exposition [SAE] Milwaukee, WI *(SAE Hqs.)*

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4-6 Convergence '82 [SAE] Dearborn, MI *(SAE Hqs.)*

4-6 Lubrication Conference [ASME] Washington, DC *(ASME Hqs.)*

4-7 Symposium on Advances and Trends in Structural and Solid Mechanics [George Washington University and NASA Langley Res. Ctr.] Washington, DC *(Prof. Ahmed K. Noor, Mail Stop 246, GWU-NASA Langley Res. Ctr., Hampton, VA 23665 - (804 827-2897)*

5-7 Western Design Engineering Show [ASME] Anaheim, CA *(ASME Hqs.)*

12-15 Stapp Car Crash Conference [SAE] Ann Arbor, MI *(SAE Hqs.)*

17-21 Power Generation Conference [ASME] Denver, CO *(ASME Hqs.)*

25-28 Advances in Dynamic Analysis and Testing [SAE Technical Committee G-5] 1982 SAE Aerospace Congress & Exposition, Anaheim, CA *(Roy W. Mustain, Rockwell Space Systems Group, Mail St. AB97, 12214 Lakewood Blvd., Downey, CA 90421)*

25-28 1982 SAE Aerospace Congress and Exposition [SAE] Anaheim, CA *(SAE Hqs.)*

26-28 53rd Shock and Vibration Symposium [Shock and Vibration Information Center, Washington, DC] Danvers, MA *(Henry C. Pusey, Director, SVIC, Naval Res. Lab., Code 5804, Washington, DC 20375)*

NOVEMBER 1982

8-10 Intl. Modal Analysis Conference [Union College] Orlando, FL *(Prof. Raymond Eisenstadt, Union College, Graduate and Continuing Studies, Wells House, 1 Union Ave., Schenectady, NY 12308 - (518) 370-6288)*

8-12 Acoustical Society of America, Fall Meeting [ASA] Orlando, FL *(ASA Hqs.)*

8-12 Truck Meeting & Exposition [SAE] Indianapolis, IN *(SAE Hqs.)*

14-19 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] Phoenix, AZ *(ASME Hqs.)*

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14-16 11th Turbomachinery Symposium [Texas A&M University] Houston, TX *(Turbomachinery Labs., Dept. of Mechanical Engineering, Texas A&M University, College Station, TX 77843 - (713) 845-7417)*

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> Unfortunately, such information is often unreliable, particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].
>
> Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and the practical applications that have been explored [3-7] indicate that . . .

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1. Platzer, M.F., "Transonic Blade Flutter - A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).
2. Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addison-Wesley (1955).
3. Jones, W.P., (Ed.), "Manual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Devel. (1962).
4. Lin, C.C., Reissner, E., and Tsien, H., "On Two-Dimensional Nonsteady Motion of a Slender Body in a Compressible Fluid," J. Math. Phys., 27 (3), pp 220-231 (1948).
5. Landahl, M., Unsteady Transonic Flow, Pergamon Press (1961).
6. Miles, J.W., "The Compressible Flow Past an Oscillating Airfoil in a Wind Tunnel," J. Aeronaut. Sci., 23 (7), pp 671-678 (1956).
7. Lane, F., "Supersonic Flow Past an Oscillating Cascade with Supersonic Leading Edge Locus," J. Aeronaut. Sci., 24 (1), pp 65-66 (1957).

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